Project Status Report

High End Computing Capability
Strategic Capabilities Assets Program

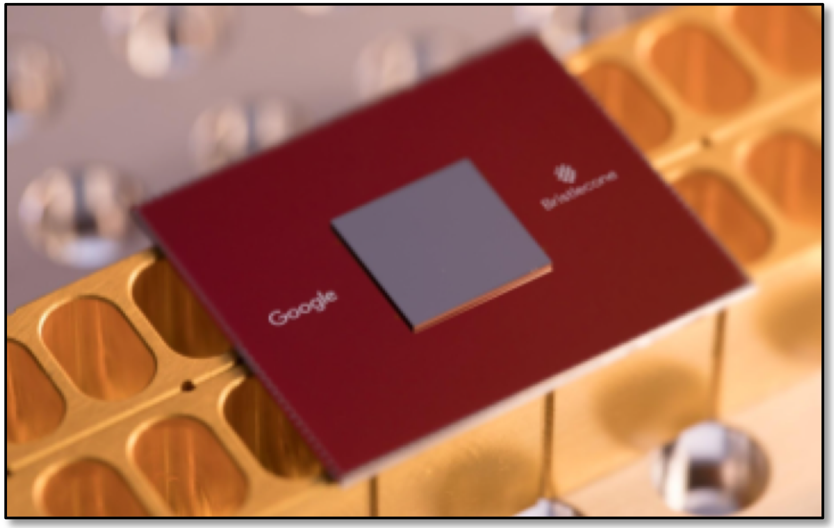
December 10, 2018

Dr. Rupak Biswas – Project Manager
NASA Ames Research Center, Moffett Field, CA
Rupak.Biswas@nasa.gov
(650) 604-4411

Quantum Circuit Simulations Run on Record Number of HECC Nodes

- In collaboration with researchers from NASA's Quantum Artificial Intelligence Laboratory (QuAIL) and Google, HECC experts successfully ran quantum circuit simulations based on Google's Bristlecone Quantum Processing Unit (QPU).
- The project included the largest calculation ever run on HECC systems.
  - At its peak, this calculation ran 116,611 processes on 13,059 nodes across the Electra, Pleiades, and hyperwall systems, using 295,867 cores and performing at nearly 20 petaflops.
  - The team ran a total of six cases simulating circuits of the quantum architecture with 48 to 70 qubits.
- Simulating quantum circuits is key to establishing quantum supremacy (the potential ability of quantum processors to surpass the capabilities of today's classical hardware). Its role includes:
  - Establishing a benchmark for comparing quantum computation with classical computation.
  - Providing verification that quantum hardware performs as expected.
- The project demonstrated a flexible, robust, high-performance simulator for verification and benchmarking. A published paper (https://arxiv.org/abs/1811.09599v1) and output results (https://data.nas.nasa.gov/quail/) are available online.

Mission Impact: This work supports the NASA QuAIL team's goal of demonstrating that quantum computing and quantum algorithms can someday solve challenging optimization and machine learning problems arising in the agency's aeronautics, Earth science, and space exploration missions.



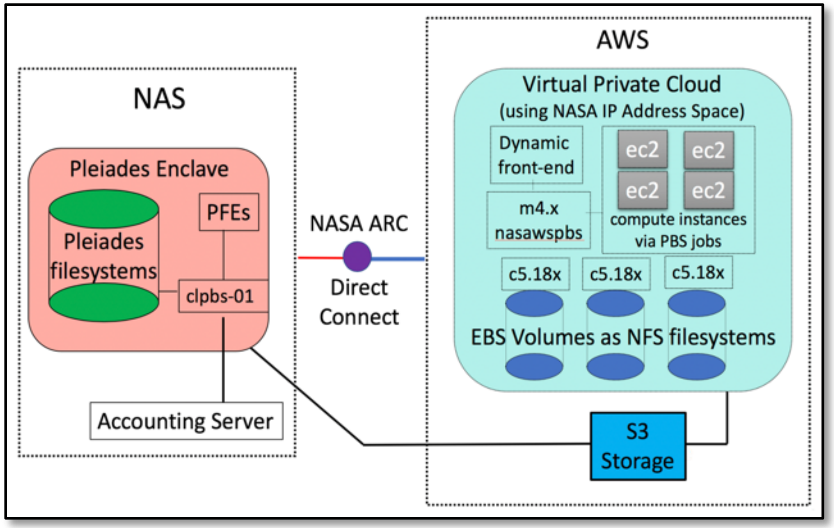
Google's Bristlecone Quantum Processing Unit (QPU). The gate-based hardware is intended to be a testbed for research including quantum simulation, an essential step toward establishing quantum supremacy.

POCs: Chris Henze, chris.henze@nasa.gov (650) 604-3959, NASA Advanced Supercomputing Division;
Salvatore Mandrà, salvatore.mandra@nasa.gov, (650) 604-4744, NASA QuAIL, SGT

Cloud Team Reduces Fixed Monthly Costs for Providing On-Demand Resources

- The HECC cloud team recently reduced the number of "always on" servers running in the cloud by 80%, significantly reducing the fixed costs associated with providing HECC users on-demand access to cloud-based resources.
- Previously, five servers were on all the time:
  - One for the Portable Batch System (PBS).
  - One to act as a front-end system.
  - Three for the file systems—one for /home and two for different /nobackup servers.
- In the new implementation, only the PBS server stays on 24x7. It spins up other servers as needed:
  - Users can run a command on Pleiades or Electra asking for a front end to be started for them.
  - The PBS server starts file servers as needed for each job. Members of the same group will share those servers.
- In addition to not paying for servers that are not in use, this strategy allows HECC to attribute most of the server costs to groups that need those services. It reduces HECC's share of the monthly server bill from ~$6,000 to ~$2,000 and makes it independent of the level of cloud usage.

Mission Impact: Having a capability that provides on-demand, cloud-based resources for computing gives HECC users an alternative to perform science and engineering calculations.



HECC is implementing the second of three phases of a project to provide on-demand access to commercial cloud resources both to its users and to other NASA customers. An important goal is to keep costs, especially those that are not easily recoverable from users, as low as possible.

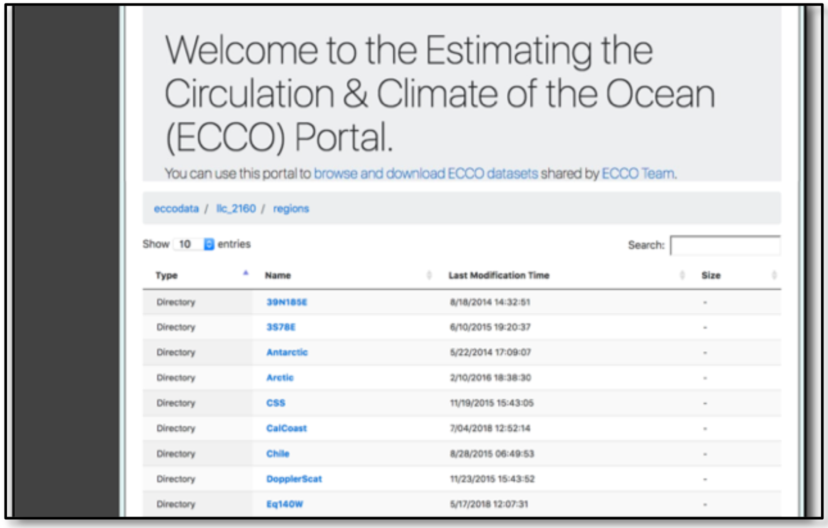
POCs: Steve Heistand, steve.heistand@nasa.gov, (650) 604-4369, and Sherry Chang, sherry.chang@nasa.gov, (650) 604-1272, NASA Advanced Supercomputing Division, ASRC

HECC Big Data Team Launches ECCO Data Portal

- The HECC big data team developed a web-based data portal to share four petabytes of datasets from the Estimating the Circulation & Climate of the Ocean (ECCO) consortium.
  - The ECCO project uses advanced ocean circulation models for a variety of oceanographic and geophysical studies.
  - Datasets are available for download, organized by region, and provided in compressed format.
- The web portal* leverages hardware and software infrastructure already being developed by the HECC big data team to create a general NAS Data Portal.
  - For example, the portal utilizes HECC's re-exporter tool to make Lustre filesystem data available outside the NAS secure enclave.
- Portal construction and security approvals were expedited to enable quick data availability to meet publication deadlines.
- Follow-on work will include serving other large datasets and providing the ability for self-serve data sharing and an automated approval process.

** Visit the ECCO data portal at: https://data.nas.nasa.gov/ecco/*

Mission Impact: Developing the Estimating the Circulation & Climate of the Ocean (ECCO) Data Portal for public sharing of ocean datasets provides opportunities for science communities and citizen scientists to collaborate and to leverage NASA data.



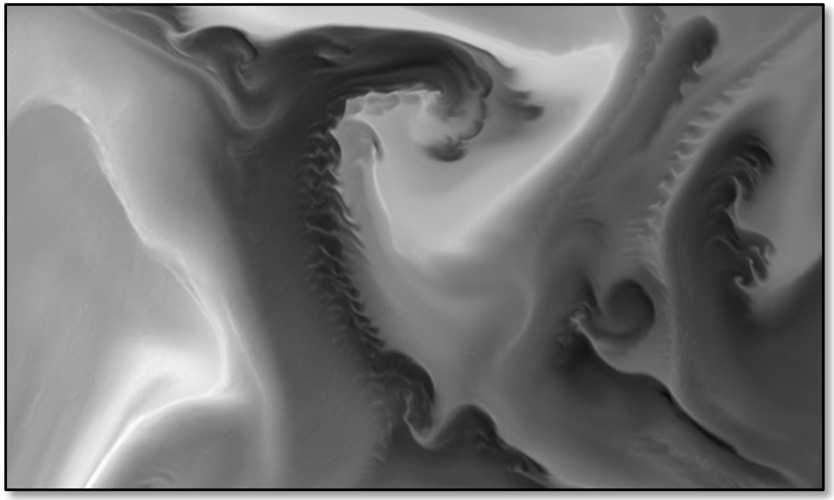
The new ECCO Data Portal enables researchers to download large datasets provided by the Estimating the Circulation & Climate of the Ocean consortium. Other computational datasets will soon be available from a general NAS Data Portal.

POCs: Shubha Ranjan, shubha.ranjan@nasa.gov, (650) 604-1918, NASA Advanced Supercomputing (NAS) Division; Ryan Spaulding, ryan.c.spaulding@nasa.gov, (408) 772-6567, NAS Division, ASRC

HECC Staff Innovations Improve Scheduling of Wide Jobs

- Wide jobs have been difficult to schedule on high-utilization clusters like Pleiades and Electra, so HECC Supercomputing Systems staff designed and implemented a mechanism to improve turnaround time for wide (large node count) jobs.
- PBSPro reservations are now leveraged to provide a regular window of opportunity for such jobs. Users who submit wide jobs have additional configuration options to make the best use of their reservations.
  - Wide jobs can experience more issues in a number of ways, from scaling, to application code design, to operating system and filesystem limits.
  - Configuration options to address these issues include extra nodes and extra time to ensure wide jobs are able to start, and allow for some debugging work if needed.
- PBSPro features developed with design input from HECC staff mitigate the loss of utilization that could occur due to draining nodes for these reservations.

Mission Impact: Large-scale computing jobs that use hundreds or even thousands of compute nodes are increasingly required to obtain advances in science and engineering for NASA missions.



This tiny piece of a computational domain, computed using the MIT General Circulation Model employed by the Estimating the Circulation and Climate of the Ocean (ECCO) project, shows swirling temperature variations just outside San Francisco Bay. This extremely high-resolution ocean model (250-meter resolution) runs on 30,000 cores of Electra, and is just one example of wide jobs running in the HECC environment.
Chris Henze, NASA/Ames

POC: Dale Talcott, dale.r.talcott@nasa.gov, (650) 604-0555,
NASA Advanced Supercomputing Division, ASRC

Successful LINPACK and HPCG Benchmark Runs on Electra

- With the recent 576-node expansion of Electra, HECC and HPE engineers ran the LINPACK and HPCG benchmarks to stress-test the system and identify any faulty components prior to release.
- Electra has a theoretical peak performance of 8.32 petaflops (PF), and achieved 5.44 PF on the LINPACK benchmark. The system ranks as the 12th most powerful computer in the U.S. and 33rd worldwide on the November 2018 TOP500 list.
- On the High Performance Conjugate Gradient (HPCG) benchmark, Electra achieved 107 teraflops (TF) and ranks 9th in the U.S. and 24th in the world on the November 2018 HPCG list.
- The LINPACK and HPCG benchmarks are widely used to evaluate the performance of different HPC systems, and provide two complementary viewpoints on systems perform on different workloads.
- Electra has made a significant impact on the agency's projects, including high-fidelity simulations for Urban Air Mobility, electric aircraft designs and quiet supersonic technology, and asteroid impact risk assessments.

Mission Impact: Running diagnostic tests on Electra enables HECC to provide a stable and productive resource for users in all mission directorates.

The Electra supercomputer is configured with 1,152 Broadwell nodes and 2,304 Skylake nodes, which now fully populate the Modular Supercomputing Facility at NASA's Ames Research Center.

POC: Davin Chan, davin.chan@nasa.gov, (650) 604-3613, NASA Advanced Supercomputing Division, ASRC

NAS Facility Expansion Project Status

- The HECC Facilities team, in collaboration with NASA Ames Code JCE and vendors Jacobs, Tri-Technic, and HPE, made significant progress on the NAS Facility Expansion (NFE).
- Construction progress includes:
  - Installed Power Vault at the NFE site.
  - Installed new switchgear at the NFE site and the building N225B substation.
  - Installed 35-kV power conductors in a new duct bank from the N225B substation to the NFE site, and landed conductors in the switchgear.
  - Installed a 115-kV circuit breaker in the N225B substation and landed conductors.
  - Trenched and installed conduit for security and access control within NFE site.
- The NASA Ames permit board are close to accepting HPE's concrete pad design. HPE and Schneider Electric will begin pad construction in mid-December.
- The modular building is being integrated at Schneider Electric's Ohio factory, with delivery set for early March 2019.
- The NFE computer system featuring Cascade Lake processors is scheduled to be available to users in April 2019.

Mission Impact: The NAS Facility Expansion will provide the infrastructure to 4 times the capacity of the existing HECC resources.

New 25-kilovolt switchgear equipment installed on top of concrete power vault at the NAS Facility Expansion (NFE) site. This switchgear will distribute up to 30 megawatts of power throughout the NFE site.

POC: Chris Tanner, christopher.tanner@nasa.gov, 650-604-6754, NASA Advanced Supercomputing Division, ASRC

NASA Honored as a "Perennial" at Annual Supercomputing Conference

- HECC staff coordinated NASA's presence at SC18, held November 12–15 in Dallas. The agency was recognized as one of 11 "perennial" organizations that have participated in the conference every year since its inception 30 years ago.
- Presenters from six NASA locations, plus university and corporate collaborators, presented 36 science and engineering projects enabled by Pleiades, Electra, and Discover and supported by HECC & NCCS visualization, optimization, and network experts.
- Featured demos highlighted for attendees included:
  - Advanced CFD tools to help design safer, greener, and quieter rotorcraft in a timely, cost-effective manner.
  - Machine learning to better predict the global water cycle and monitor water's role in Earth's ecosystems.
  - CFD simulations to evaluate design choices for improving key launch pad components.
  - Global 3D models and high-resolution scientific visualization of the sun's magnetic field to help predict the effects of space weather.
- Eye-catching images and movies from simulations, many created by HECC visualization experts, were shown on the 10x6-foot mini-hyperwall; dozens of high-resolution images and videos were made available on the NASA@SC18 website* (see slide 10).
- Rupak Biswas was elected to the SC Steering Committee; Biswas, along with Tsengdar Lee and Piyush Mehrotra, met with SC18 Chair Ralph McEldowney to discuss more ways NASA can expand its participation in future SC conferences.

** Visit the NASA@SC18 website at: www.nas.nasa.gov/SC18/*

Mission Impact: SC18 provided a highly visible public platform to showcase NASA science and engineering missions supported by the agency's high-end computing resources, as well as NASA's latest research and advances in HPC technologies.

Top: Support team and presenters gave attendees a great NASA experience at SC18. Bottom: Rupak Biswas, Piyush Mehrotra, Tsengdar Lee, Bill Thigpen, and Gina Morello accept the "perennial" award from the SC18 Chair.

POC: Gina Morello, gina.f.morello@nasa.gov, (650) 604-4462, NASA Advanced Supercomputing Division

Tools Team Highlights NASA Presence at Annual Supercomputing Conference

- The HECC Tools team worked closely with the Pubs Media team to gather and present content from HECC users who gave demonstrations at the SC18 conference in Dallas.
- The Tools team created and maintained internal and public-facing websites that support NASA's presence each year at the supercomputing conference. These include:
  - A content upload site, where the researchers associated with each demonstration transmit their text, images, and videos to the Pubs Media team.
  - The main NASA@SC18 website, which draws thousands of visitors from the HPC community, the media, and the public. This year, the tools team made several improvements to the site, including a scrolling "SC18 News" box for the front page and updated design elements throughout.
  - Websites that drive the two animated schedule screens in this year's NASA booth. Scripts pull data from a Google calendar with information on over 120 booth events. The calendar also supplies data to schedule pages on the main NASA@SC18 website and an iPad at the booth information desk. This approach enables scheduling changes during the conference to be reflected across all platforms within moments.
  - Animated screens celebrating the 30th anniversary of SC conferences (and NASA's presence at each one) for the opening night gala.
  - Animated screens to be shown during breaks when there are no scheduled speakers in a presentation area.

Mission Impact: NASA@SC websites call attention to the agency's supercomputing, science, and engineering outreach activities before, during, and after the annual supercomputing conference.

The NASA@SC18 website features more than 150 images and 17 videos taken from 36 demonstrations presented in the NASA booth. Each demonstration has its own page on the site to explain the details, results and impact of the research. Supercomputing related news and information were updated by the Tools team throughout the conference.
Visit: https://www.nas.nasa.gov/SC18/

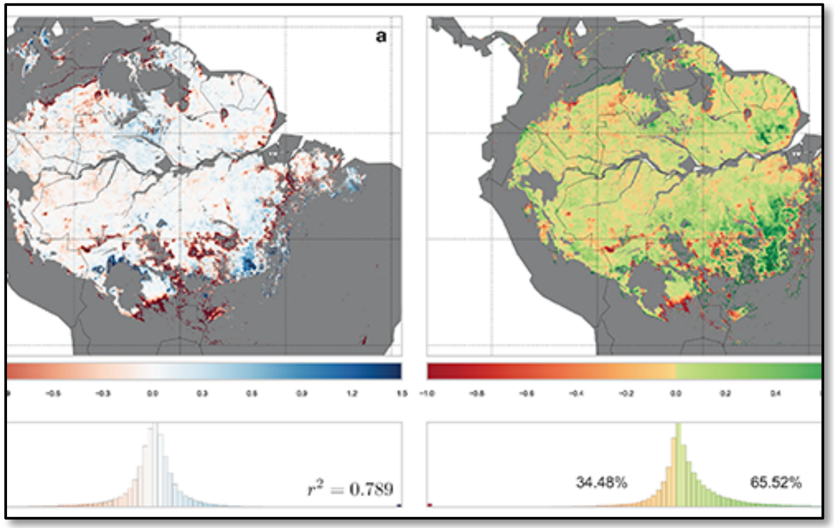
POC: John Hardman, john.hardman@nasa.gov, (650) 604-0417, NASA Advanced Supercomputing Division, ASRC

Using Machine Learning to Understand the Amazon Rainforests*

- Researchers at NASA Ames used a machine learning and optimization-based approach to quantify the governing equation of climate-vegetation dynamics in the Amazon rainforest.
- This data-driven approach learns nonlinear relationships while making minimal assumptions about the structural form of the underlying system, and constructed models are optimized to accurately explain the data and to be easily interpreted.
- Using genetic-programming based symbolic regression, the Ames team discovered unknown but ecologically meaningful interactions between remotely sensed climatic factors and vegetation productivity in the Amazon.
  - Models also helped correctly infer the state of vegetation in the Amazon, given climate projections that accurately mimic real-world observations.
  - Analysis showed that increased temperature is a more important factor than reduced precipitation in causing loss of photosynthetic capacity.
- The project benefitted from the use of HECC resources through access to both NASA Earth Exchange (NEX) datasets and Pleiades nodes for high-memory data preprocessing and running the genetic programming search algorithm.

** HECC provided supercomputing resources and services in support of this work.*

Mission Impact: HECC resources enabled NASA researchers to quantify the dependency of vegetation greenness in the Amazon rainforest on rainfall and temperature, and explaining the observations made by NASA satellites in different regions.



At left: spatial patterns of prediction errors of an Amazon region GP-tree model, averaged over the years 2003–2010. Positive and negative values indicate underestimated and overestimated vegetation predictions, respectively. The model captures almost 80% variation in the data, a 10% improvement over a linear model. At right: Differences in prediction errors between linear and nonlinear models. Green color indicates locations where the model provides more accurate predictions.

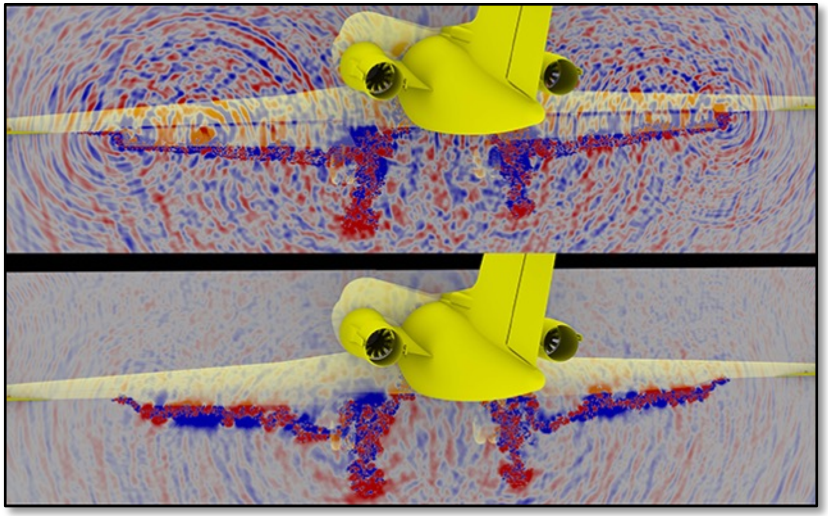
POC: Kamalika Das, kamalika.das@nasa.gov, (650) 604-0449, NASA Ames Research Center, USRA

Pleiades Simulations Help Evaluate New Airframe Noise Reduction Technologies*

- Aerospace engineers at NASA Langley ran high-fidelity, time-accurate simulations on Pleiades to evaluate aeroacoustic performance of noise reduction technologies as installed on a full-scale Gulfstream III (G-III) aircraft.
- The simulations supported an extensive flight test campaign demonstrating two technologies that could reduce airframe noise by more than 70%:
  - Adaptive Compliant Trailing Edge (ACTE) flap that replaced the existing flap system on the test aircraft.
  - Porous and non-porous fairings fitted around the flow-facing components of the main landing gear.
- Insights gained from the simulations benefited the flight test campaign in several ways, including:
  - Provided the capability to conduct system-level, full-scale evaluations of the noise reduction hardware prior to the test, which enabled selection of the most promising configurations for testing.
  - Helped design engineers tailor and retrofit the gear fairings into the main landing gear of the G-III aircraft through several iterations, ensuring that their noise reduction effectiveness was not compromised.
- Modeling the full-scale G-III in landing configuration required a very large mesh of 17 billion cells.

** HECC provided supercomputing resources and services in support of this work.*

Mission Impact: Simulation-based prediction of airframe noise is essential for designing practical noise reduction strategies—a key goal of NASA's Aeronautics Research Mission Directorate (ARMD). This work directly supports the ARMD Integrated Aviation Systems Program's Flight Demonstrations and Capabilities Project.



Sound waves emanating from a full-scale Gulfstream G-III aircraft during approach without noise reduction technologies (top) and with wing flap and main landing gear noise reduction technologies added (bottom). Red and blue contours represent maximum and minimum sound pressure levels, respectively. *Ryan Ferris, Exa Corporation; Patrick Moran, NASA/Ames*

POC: Mehdi Khorrami, mehdi.r.khorrami@nasa.gov, (757) 864-3630, NASA Langley Research Center

Papers

- "**Exploring the Influence of Density Contrast on Solar Near-Surface Shear**," L. Matilsky, et al., arXiv:1811.00665 [astro-ph.SR], November 1, 2018. *
  https://arxiv.org/abs/1811.00665
- "**Instability Wave-Streak Interactions in a High Mach Number Boundary Layer at Flight Conditions**," P. Parades, M. Choudhari, F. Li, *Journal of Fluid Mechanics*, vol. 858, published online November 6, 2018. *
  https://bit.ly/2DYVSfg
- "**Effect of the Reconnection Field on Electron Distribution Functions in the Diffusion Region of Magnetotail Reconnection**," N. Bessho, et al., *Geophysical Research Letters*, published online November 12, 2018. *
  https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2018GL081216
- "**The Relation Between Galaxy ISM and Circumgalactic OVI Gas Kinematics Derived from Observations and ΛCDM Simulations**," G. Kacprzak, et al., arXiv:1811.06028 [astro-ph.GA], November 14, 2018. *
  https://arxiv.org/abs/1811.06028
- "**Southern California Megacity CO_2, CH_4, and CO Flux Estimates Using Ground- and Space-Based Remote Sensing and a Lagrangian Model**," J. Hedelius, et al., Atmospheric Chemistry and Physics, vol. 18, November 16, 2018. *
  https://www.atmos-chem-phys.net/18/16271/2018/acp-18-16271-2018-discussion.html
- "**Phase Transformation as the Mechanism of Mechanical Deformation of Vertically Aligned Carbon Nanotube Arrays: Insights from Mesoscopic Modeling**,"
  B. Wittmaack, et al., Carbon, vol. 143, published online November 21, 2018. *
  https://www.sciencedirect.com/science/article/pii/S0008622318310972

** HECC provided supercomputing resources and services in support of this work*

Papers (cont.)

- "**A Flexible High-Performance Simulator for the Verification and Benchmarking of Quantum Circuits Implemented on Real Hardware**," B. Villalonga, S. Boixo, B. Nelson, C. Henze, et al., arXiv:1811.09599 [quant-ph], November 23, 2018. *https://arxiv.org/abs/1811.09599*
- "**Collapsed Carbon Nanotubes: From Nano to Mesoscale via Density Functional Theory-Based Tight-Binding Objective Molecular Modeling**," H. Xu, et al., Carbon (accepted manuscript), published online November 24, 2018. * *https://www.sciencedirect.com/science/article/pii/S0008622318310996*
- "**A Comprehensive Three-Dimensional Radiative Magnetohydrodynamic Simulation of a Solar Flare**," M. Cheung, et al., Nature Astronomy, November 26, 2018. * *https://www.nature.com/articles/s41550-018-0629-3*
- "**Nose-Tip Bluntness Effects on Transition at Hypersonic Speeds**," P. Paredes, et al., Journal of Spacecraft and Rockets (pre-press), published online November 26, 2018. * *https://arc.aiaa.org/doi/abs/10.2514/1.A34277*
- "**Dwarf Galaxies in CDM, WDM, and SIDM: Disentangling Baryons and Dark Matter Physics**," A. Fitts, et al., arXiv:1811.11791 [astro-ph.GA], November 28, 2018. * *https://arxiv.org/abs/1811.11791*
- "**Collisionless Relaxation of the Ion Ring Distribution in Space Plasma**," L. Ofman, et al., Planetary and Space Science, published online November 30, 2018. * *https://www.sciencedirect.com/science/article/pii/S0032063318301557*

** HECC provided supercomputing resources and services in support of this work*

Presentations

- **2018 Supercomputing Conference,** Dallas, TX, November 12–16, 2018.
  - "**Advanced CFD Tools for Accurate Rotorcraft Analysis and Design**," N. Chaderjian. *
    https://www.nas.nasa.gov/SC18/demos/demo1.html
  - "**Using Retrorockets for Human Exploration of Mars**," C. Tang. *
    https://www.nas.nasa.gov/SC18/demos/demo2.html
  - "**NASA's Module-Based Approach to Greener Computing**," W. Thigpen.
    https://www.nas.nasa.gov/SC18/demos/demo4.html
  - "**What Role Should Commercial Clouds Play in NASA HPC?**" R. Hood, H. Jin.
    https://www.nas.nasa.gov/SC18/demos/demo5.html
  - "**Predicting Aircraft and Spacecraft Acoustics**," C. Kiris.
    https://www.nas.nasa.gov/SC18/demos/demo6.html
  - "**High-Resolution Launch Environment Simulations**," M. Barad, C. Kiris. *
    https://www.nas.nasa.gov/SC18/demos/demo7.html
  - "**Parametric Studies of Asteroid Impact**," M. Aftosmis, M. Nemec. *
    https://www.nas.nasa.gov/SC18/demos/demo8.html
  - "**Aerodynamic Databases for the Space Launch System**," H. Lee, S. Rogers. *
    https://www.nas.nasa.gov/SC18/demos/demo9.html
  - "**Computational Simulations of Next-Generation Aircraft**," J. Angel, C. Kiris. *
    https://www.nas.nasa.gov/SC18/demos/demo10.html
  - "**Lattice Boltzmann Simulations for Analyzing UAM Vehicle Propeller Noise**," M. Piotrowski, el al. *
    https://www.nas.nasa.gov/SC18/demos/demo11.html
  - "**To Find Other Earths, We Need to Understand Other Suns**," A. Wray, I. Kitiashvili. *
    https://www.nas.nasa.gov/SC18/demos/demo12.html

** HECC provided supercomputing resources and services in support of this work*

Presentations (cont.)

- **2018 Supercomputing Conference (cont.)**
  - "**Hypervelocity Sampling of Venus' Noble Gases**," A. Borner, J. Rabinovitch. *
    https://www.nas.nasa.gov/SC18/demos/demo13.html
  - "**Extreme Plasma Modeling for Planetary Entry and Space Exploration**," S. Visser, N. Mansour. *
    https://www.nas.nasa.gov/SC18/demos/demo14.html
  - "**Towards Urban Air Mobility: The Side-by-Side Air Taxi**," P. Ventura Diaz, S. Yoon. *
    https://www.nas.nasa.gov/SC18/demos/demo15.html
  - "**Simulations Provide Insight into Shock Wave/Boundary-Layer Interactions**," M. Vyas, et al. *
    https://www.nas.nasa.gov/SC18/demos/demo16.html
  - "**Simulating Swirling Disks of Matter Around White Dwarf Stars**," O. Blaes, Y.-F. Jiang. *
    https://www.nas.nasa.gov/SC18/demos/demo17.html
  - "**Aircraft Noise Reduction Technologies Come in for a Landing**," M. Khorrami. *
    https://www.nas.nasa.gov/SC18/demos/demo18.html
  - "**Lighting the Fire: High Fidelity Combustion Modeling for Deep-Space Exploration**," B. Richardson *
    https://www.nas.nasa.gov/SC18/demos/demo19.html
  - "**Preparing the FUN3D CFD Solver for the Exascale Era**," E. Nielsen, A. Walden. *
    https://www.nas.nasa.gov/SC18/demos/demo20.html
  - "**Shields Up! Towards Forecasting Solar Particle Threats Through Simulation**," R. Caplan, et al. *
    https://www.nas.nasa.gov/SC18/demos/demo21.html
  - "**Simulation of Shuttle SRB Ignition Transient with Sound Suppression Water**," A. Weaver, et al. *
    https://www.nas.nasa.gov/SC18/demos/demo23.html
  - "**An Exciting Year in Quantum Computing Research at NASA**," E. Rieffel, R. Biswas
    https://www.nas.nasa.gov/SC18/demos/demo24.html

** HECC provided supercomputing resources and services in support of this work*

Presentations (cont.)

- **2018 Supercomputing Conference (cont.)**
  - “**Understanding the Amazon Rainforests Using Machine Learning**,” K. Das. *
    https://www.nas.nasa.gov/SC18/demos/demo25.html
  - “**Is OpenMP 4.5 Ready for Real Life?**” G. Jost.

** HECC provided supercomputing resources and services in support of this work*

News and Events

- **NASA Brings its Science and Supercomputing Advances to SC18**, *NASA Press Release*, November 5, 2018—From designing rocket launch pad components and safer rotorcraft to improving flood and drought forecasts to modeling the formation of planetary disks, NASA will highlight supercomputing advances at SC18, Nov. 12 to 15 in Dallas, TX. *https://www.nasa.gov/feature/nasa-brings-its-science-and-supercomputing-advances-to-sc18*
- **Google and NASA Tackle Quantum Supremacy**, *HPCwire*, November 6, 2018—NASA and Google are collaborating to explore the use of gate-mode quantum processors and new approaches to solving complex computing challenges. *https://www.hpcwire.com/2018/11/06/google-and-nasa-tackle-quantum-supremacy/*
  - **Google Has Enlisted NASA to Help it Prove Quantum Supremacy Within Months**, *MIT Technology Review*, November 5, 2018. *https://www.technologyreview.com/s/612381/google-has-enlisted-nasa-to-help-it-prove-quantum-supremacy-within-months/*
- **SC 30th Anniversary Perennials 1988-2018**, *HPCwire*, November 8, 2018—At SC18, NASA is being recognized as one of just eleven "perennial" organizations that have exhibited at each SC conference since its inception in 1988. *https://www.hpcwire.com/2018/11/08/sc-30th-anniversary-perennials/*
- **NASA's Electra Supercomputer Rises to 12th Place in the US on the TOP500 List**, *NAS News Story*, November 12, 2018—Recently expanded, NASA's first modular supercomputer has moved to 12th place in the ranking of the most powerful computers in the United States, and is 33rd worldwide on the November 2018 TOP500 list. *https://www.nas.nasa.gov/publications/news/2018/11-12-18.html*

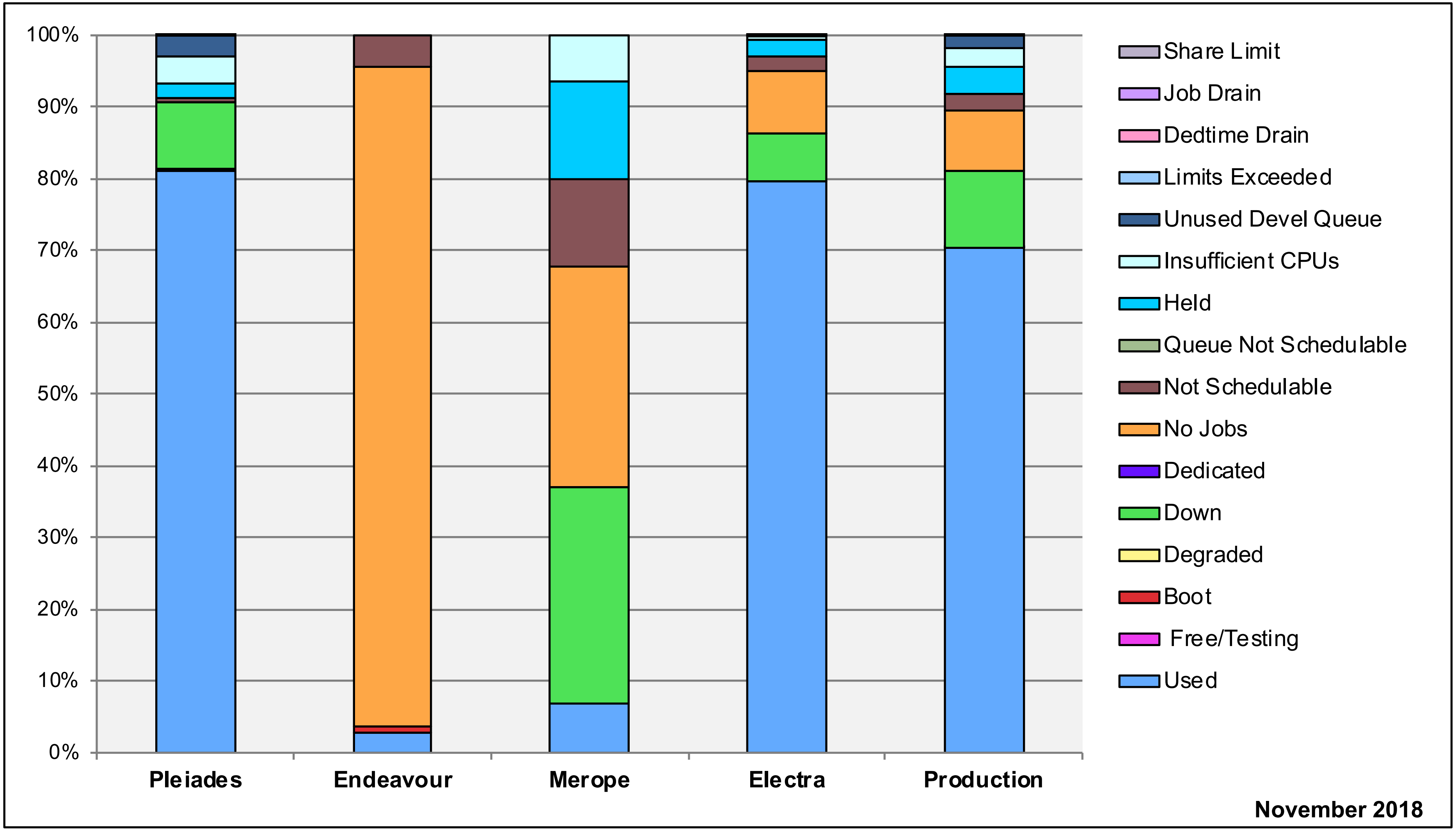
News and Events (cont.)

- **HPCwire Reveals Winners of the 2018 Readers' and Editors' Choice Awards at SC18 Conference in Dallas, TX**, *HPCwire*, November 12, 2018—NASA teams and partners were honored with two HPCwire Reader's Choice Awards this year for the astronaut Twin Study and the Spaceborne computer. NASA's High-End Computing Program Manager Tsengdar Lee and Director of Exploration Technology at NASA Ames Rupak Biswas accepted the awards, presented by HPCwire President Tom Tabor.
  https://www.hpcwire.com/off-the-wire/hpcwire-reveals-winners-of-the-2018-readers-and-editors-choice-awards-at-sc18-conference-in-dallas-tx/
- **NASA Missions to Benefit from New Cloud Computing Services**, *NASA High-End Computing Program Release*, November 13, 2018—NASA-funded scientific and engineering projects will get a boost from a new cloud computing service that expands the agency's range of high-performance computing service offerings. Through a secure, managed cloud environment approach, the NASA Advanced Supercomputing (NAS) facility and the NASA Center for Climate Simulation (NCCS) will provide supported access to resources at commercial cloud providers.
  https://www.hec.nasa.gov/news/features/2018/cloud_computing_services.html
- **Supercomputers Help Aircraft Noise Reduction Technologies Come in for a Landing**, *NAS Feature Story,* November 15, 2018—Supported by high-fidelity, full-scale aircraft simulations run on the Pleiades supercomputer, NASA flight tests recently demonstrated new ways to reduce airframe noise without impacting aerodynamic performance.
  https://www.nas.nasa.gov/publications/articles/feature_aircraft_noise_reduction_Khorrami.html

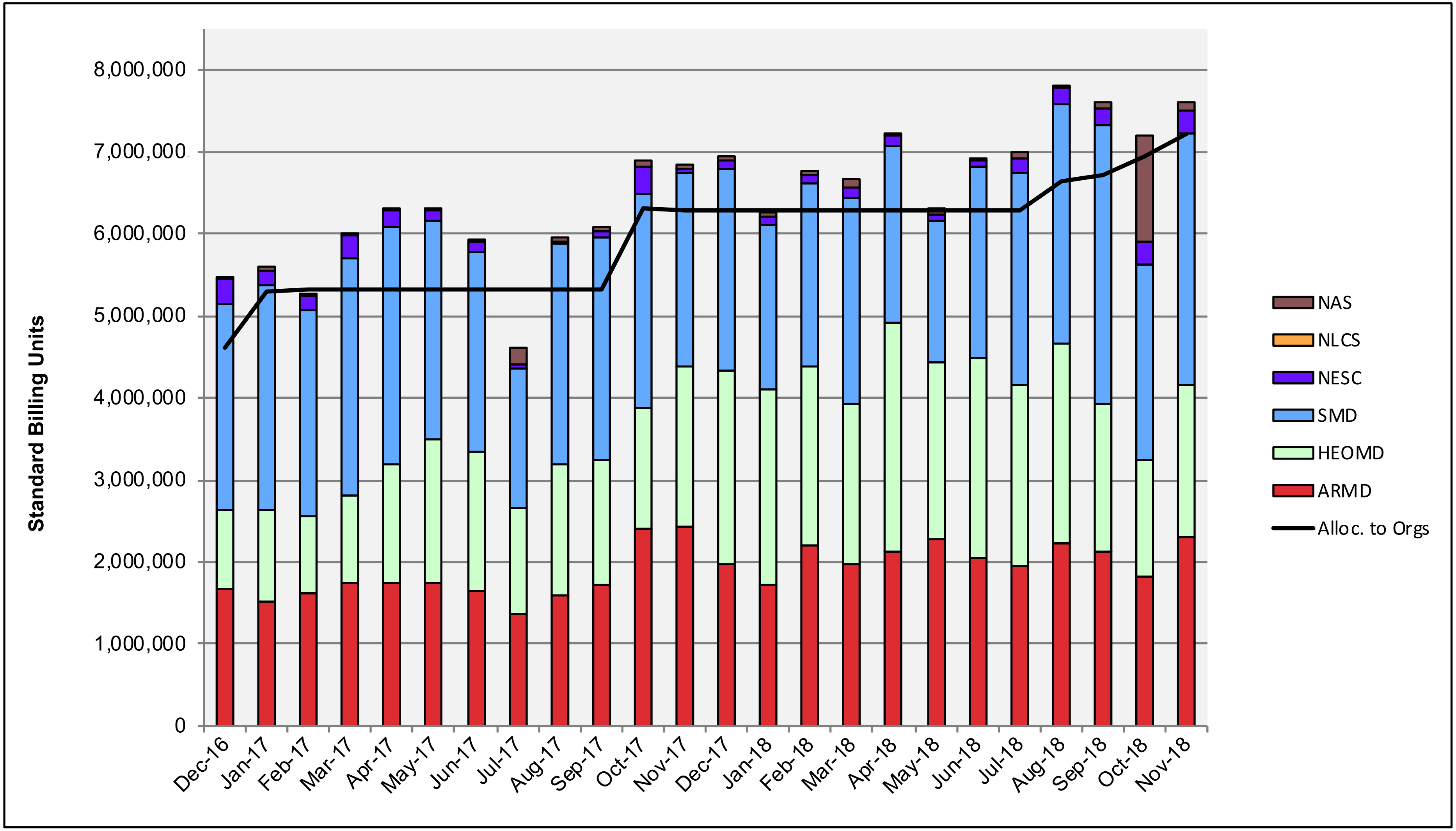
News and Events (cont.)

- **Toward Urban Air Mobility: Air Taxis with Side-by-Side Rotors**, *NASA Ames Image Feature*, November 15, 2018—High-resolution simulations of NASA's side-by-side, intermeshing rotor air taxi concept allow researchers to understand complex rotor air flow interactions. *https://www.nasa.gov/feature/ames/toward-urban-air-mobility-air-taxis-with-side-by-side-rotors*
  - **NASA HQ Urban Air Mobility Image Feature Twitter Post** (515 Retweets, 2.2K Likes), November 18, 2018. *https://twitter.com/NASA/status/1064200709275553794*
- **NJIT Launches Potent Research Hub: Institute for Space Weather Sciences**, *New Jersey Institute of Technology News*, November 28, 2018—The New Jersey Institute of Technology is forming a multidisciplinary institute to advance both theoretical and applied research on the effects of space weather on civilization, including modeling and big data analytics experts at the Center for Computational Heliophysics and the NASA Advanced Supercomputing Division. *https://news.njit.edu/njit-launches-institute-space-weather-sciences*

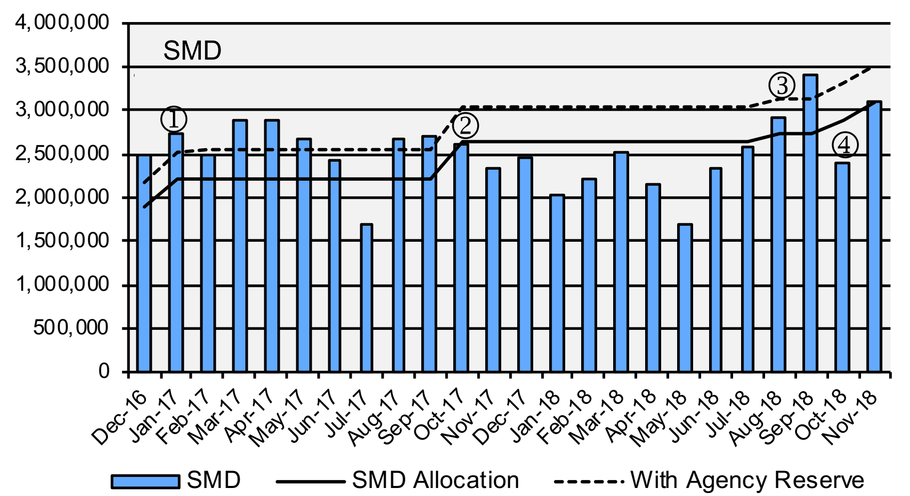
HECC Utilization

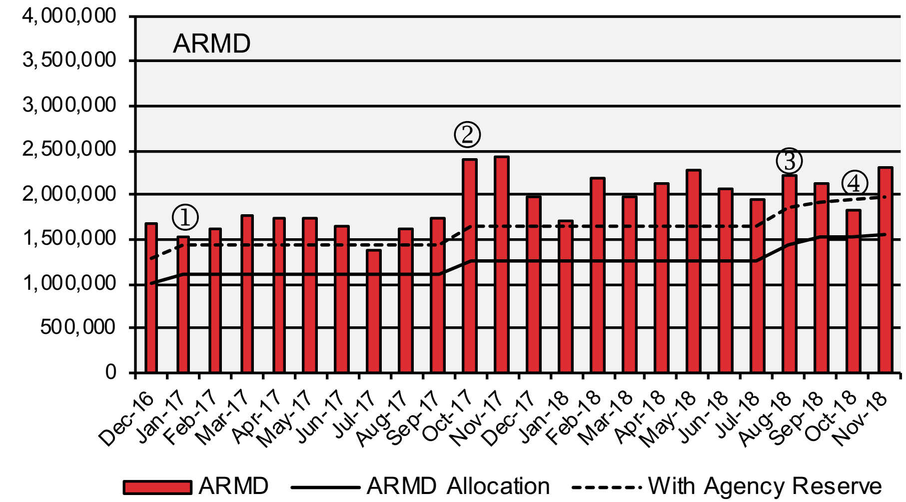


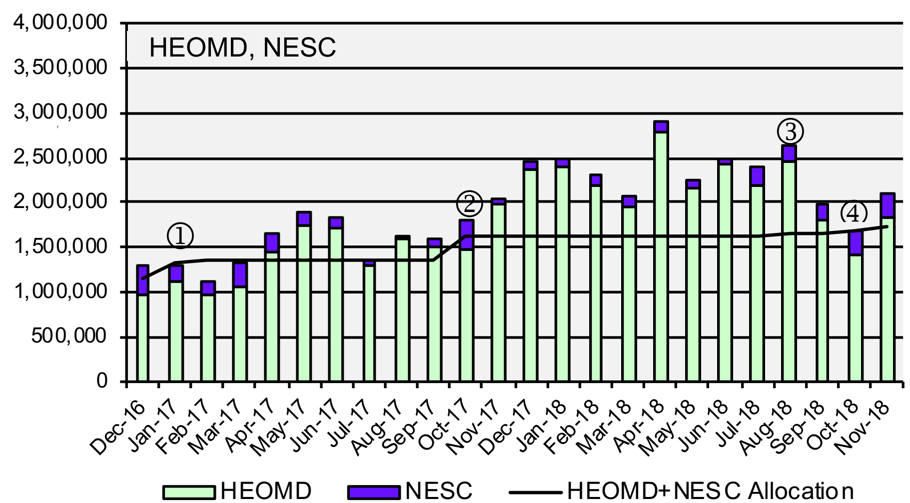
HECC Utilization Normalized to 30-Day Month



HECC Utilization Normalized to 30-Day Month







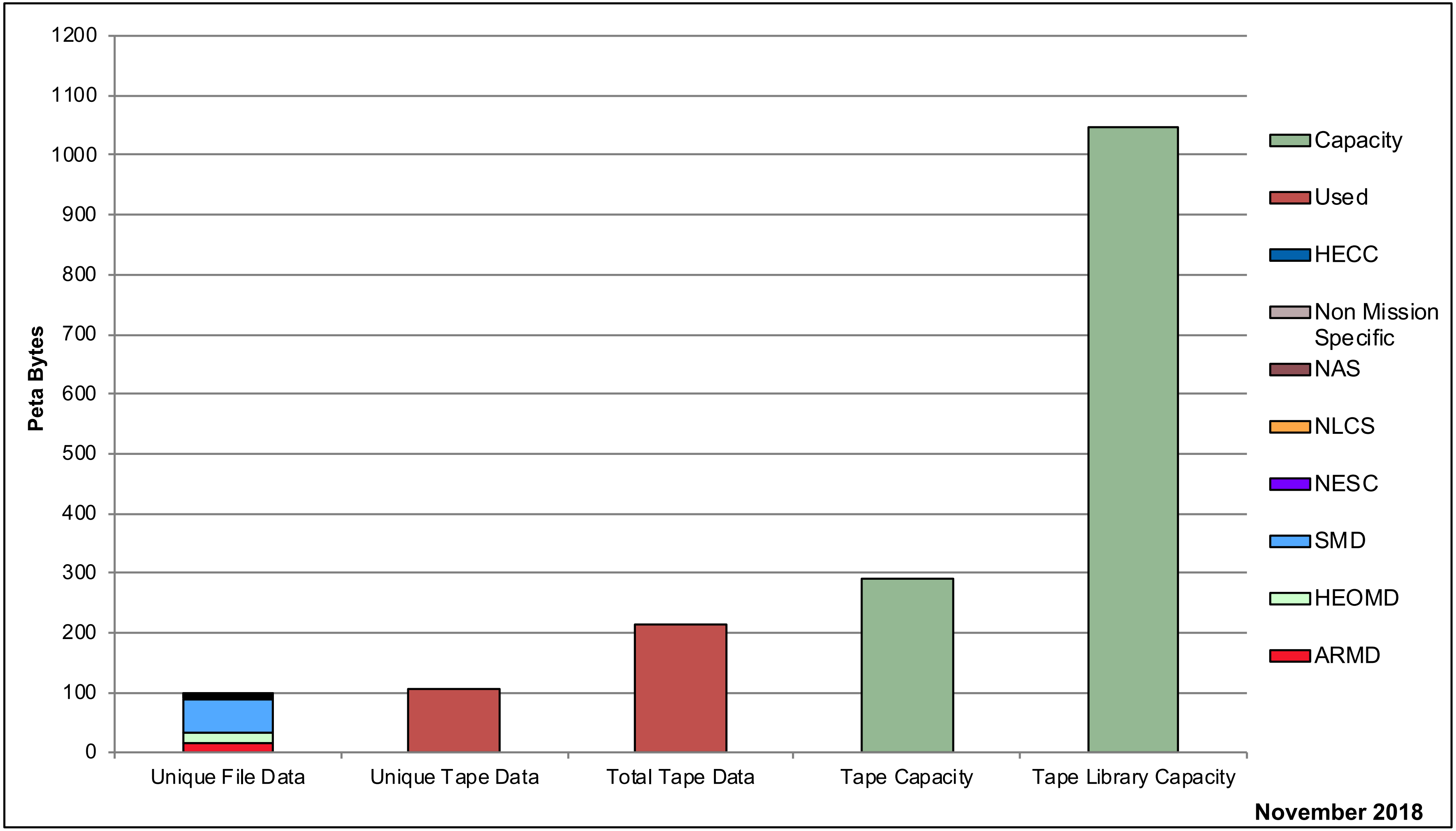
① 16 Broadwell racks added to Electra, 20 Westmere half racks added to Merope

② 4 Skylake E cells (16 D Rack Equivalence) added to Electra

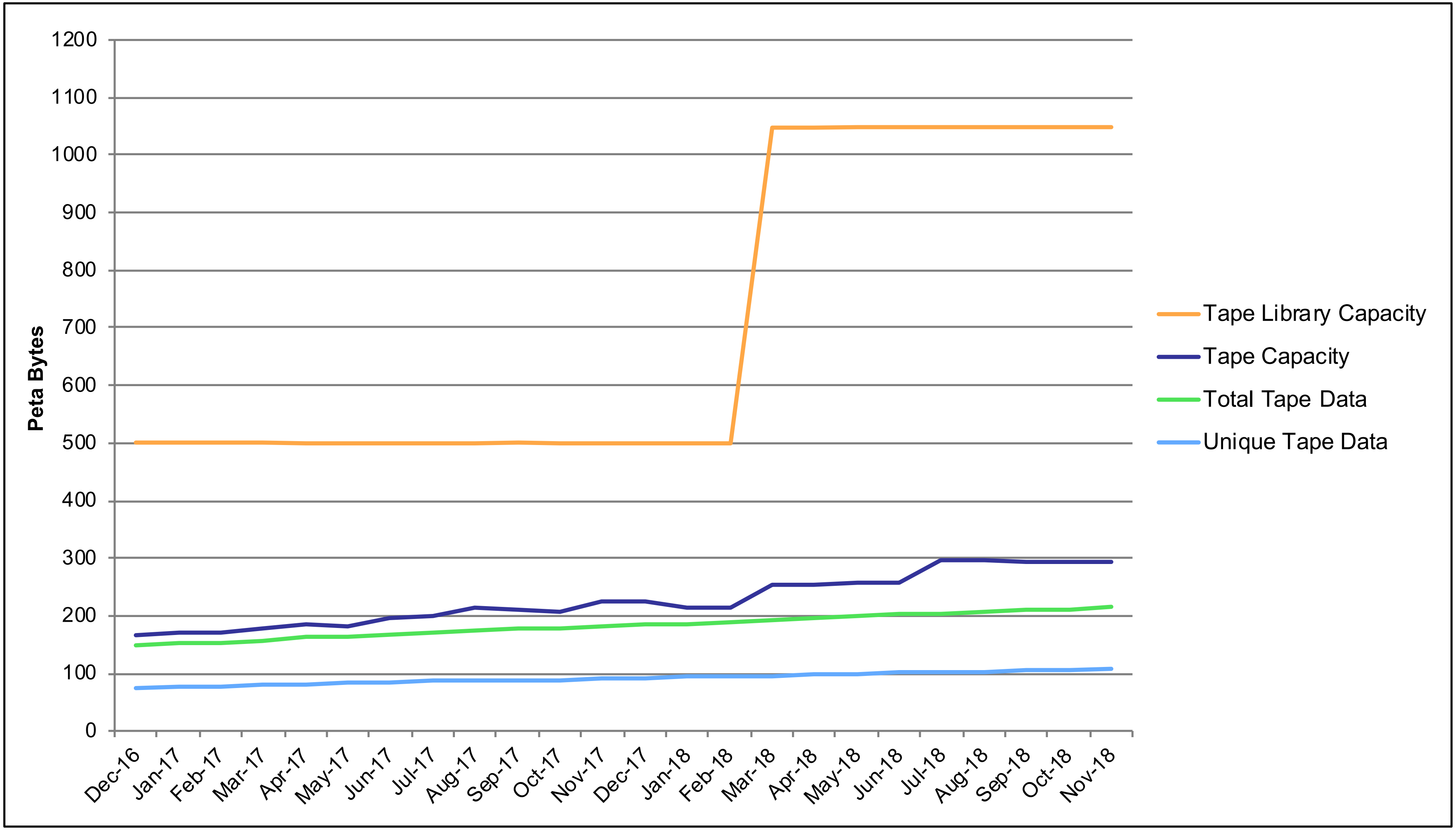
③ 2 Skylake E cells (8 D Rack Equivalence) added to Electra; 1 rack is dedicated to ARMD

④ 2 Skylake E cells (8 D Rack Equivalence) added to Electra; 1 rack is dedicated to SMD

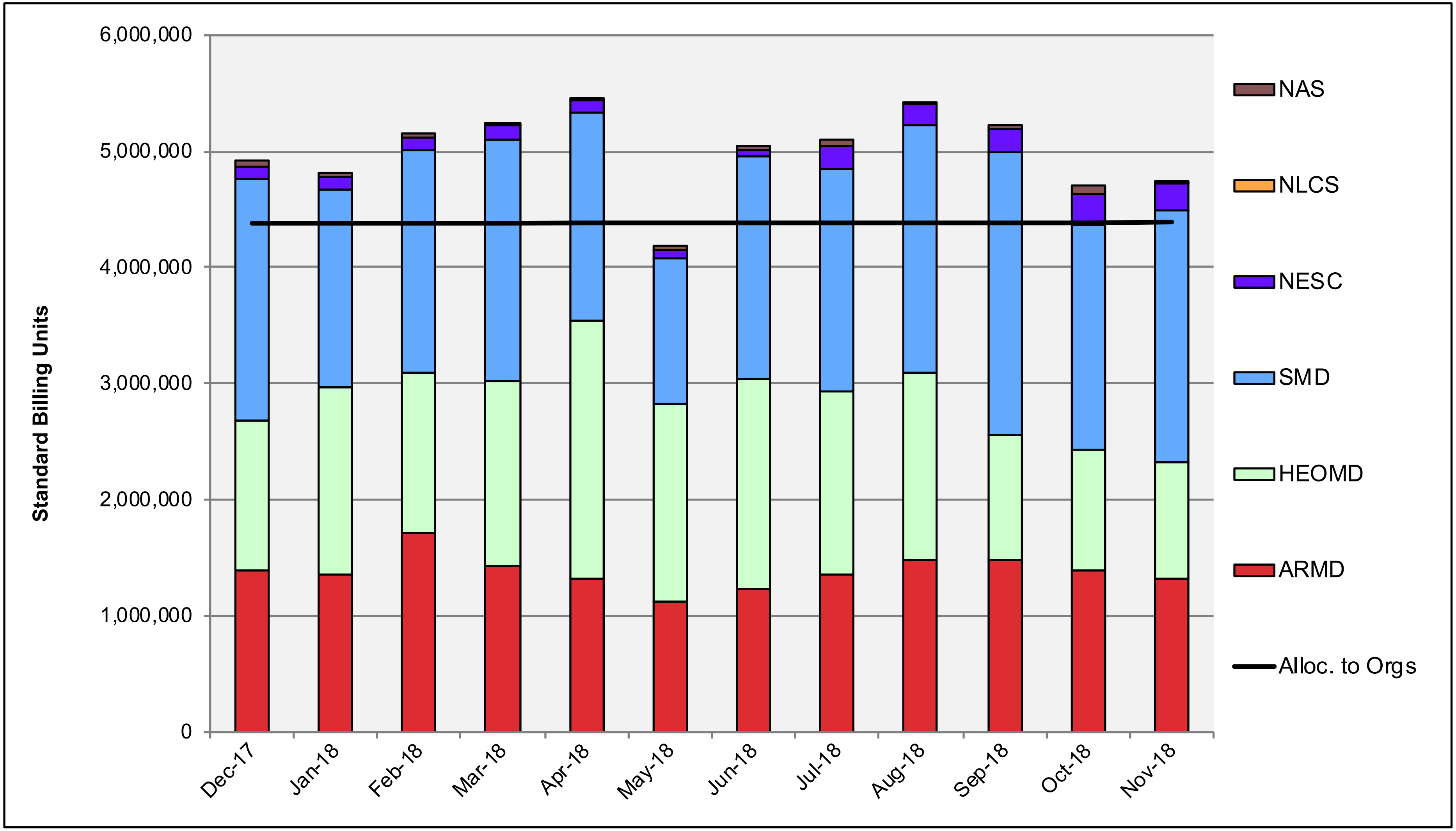
Tape Archive Status



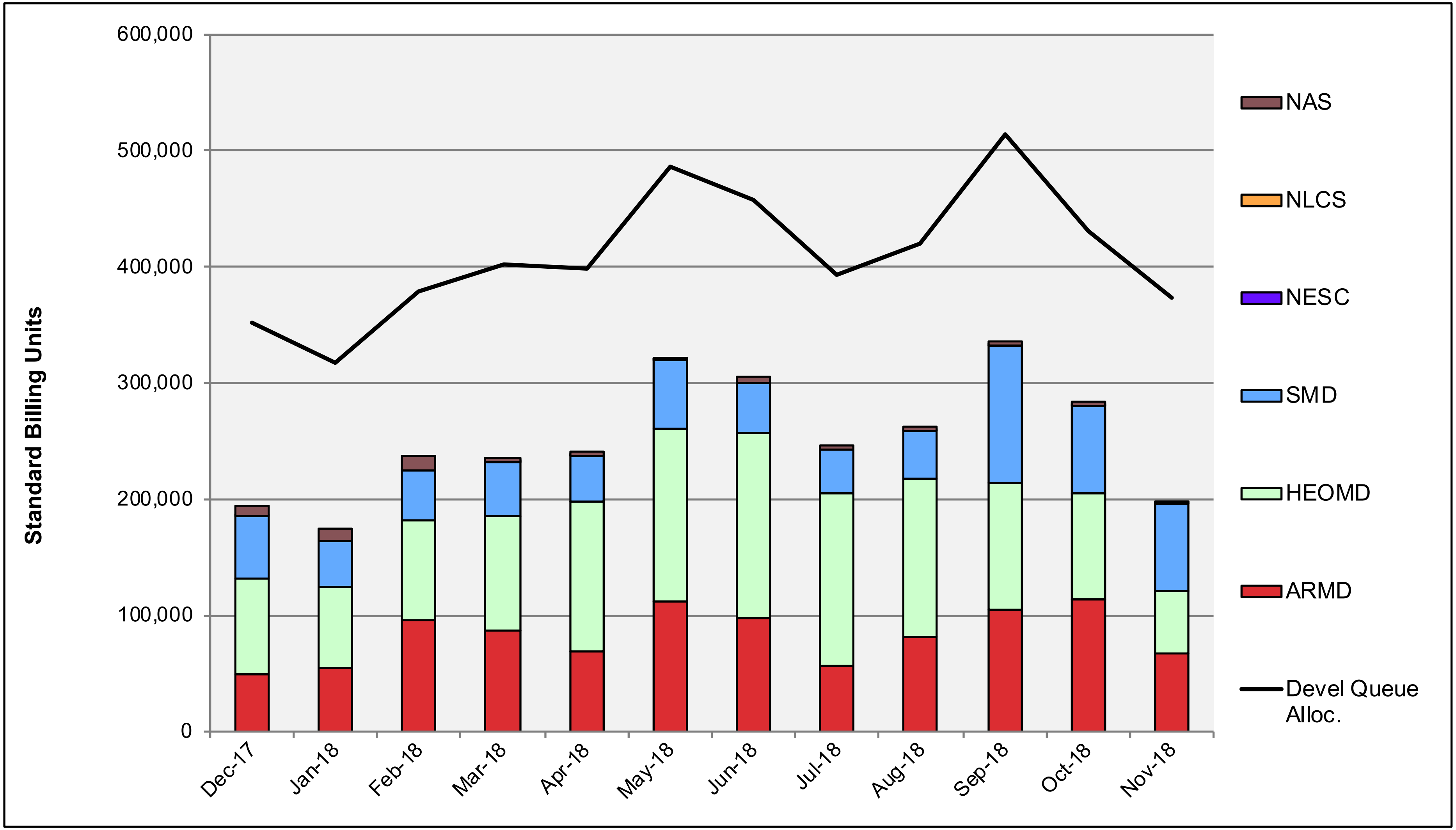
Tape Archive Status



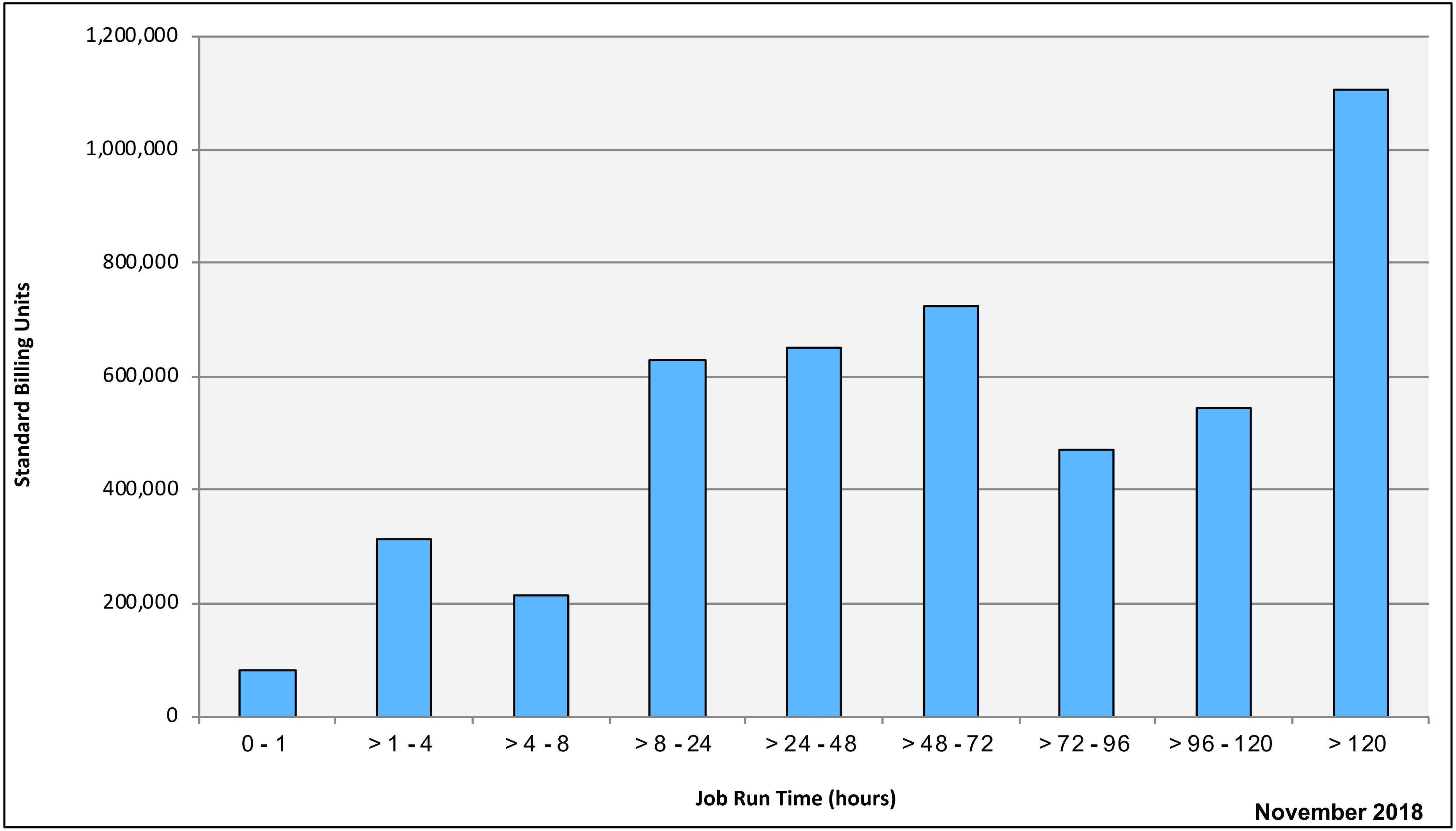
Pleiades: SBUs Reported, Normalized to 30-Day Month



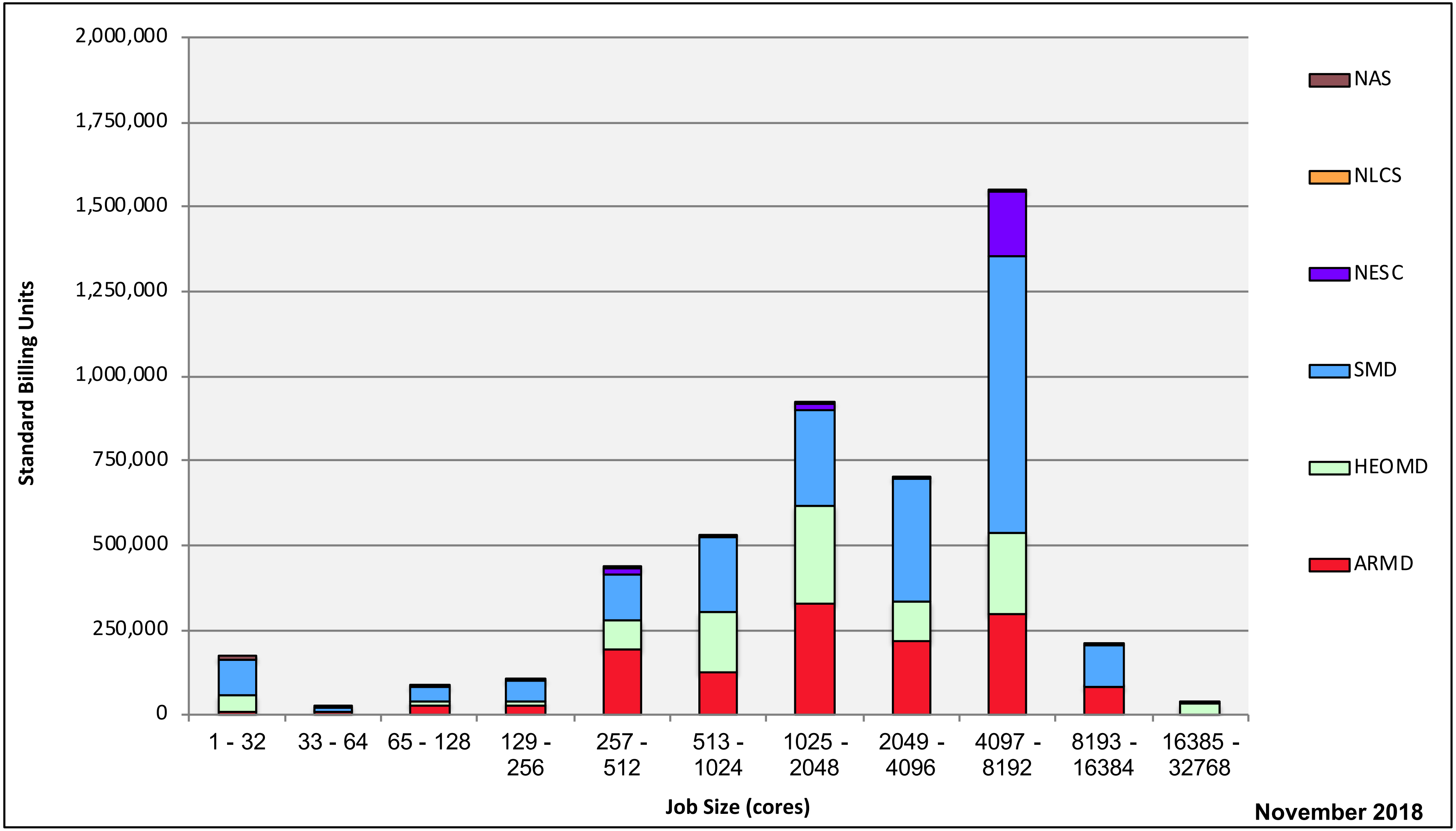
Pleiades: Devel Queue Utilization



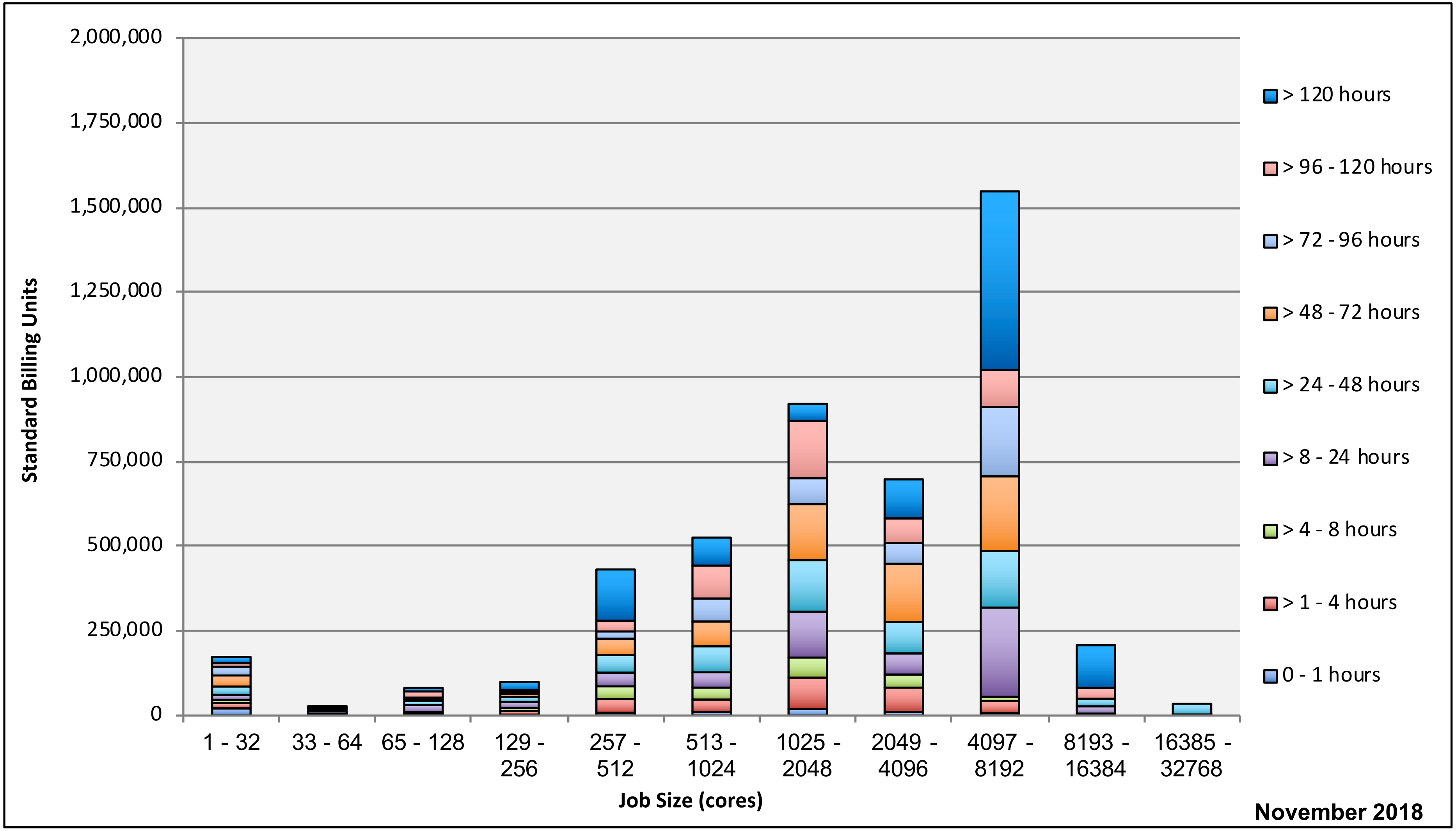
Pleiades:
Monthly Utilization by Job Length



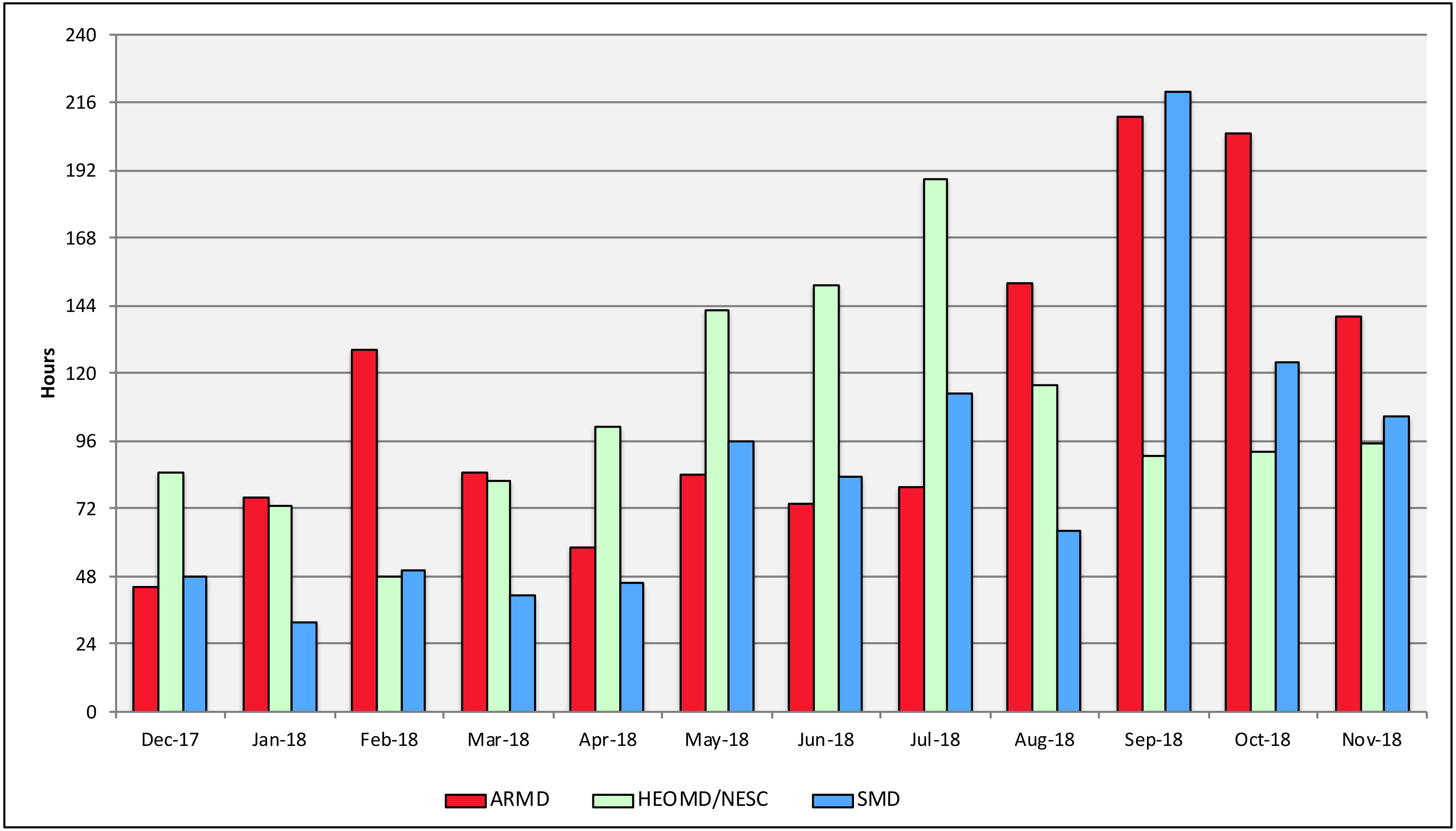
Pleiades: Monthly Utilization by Size and Mission



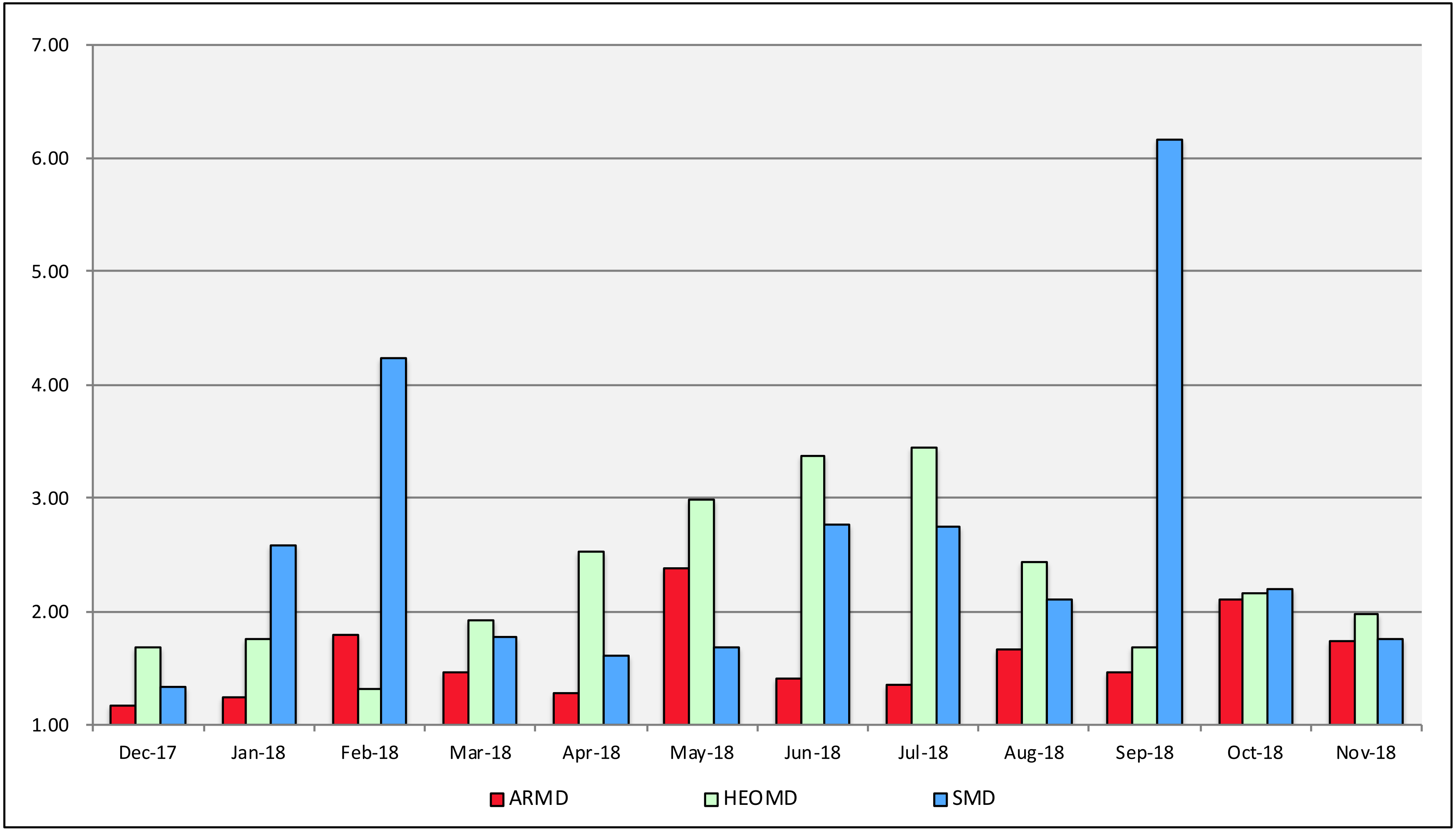
Pleiades:
Monthly Utilization by Size and Length



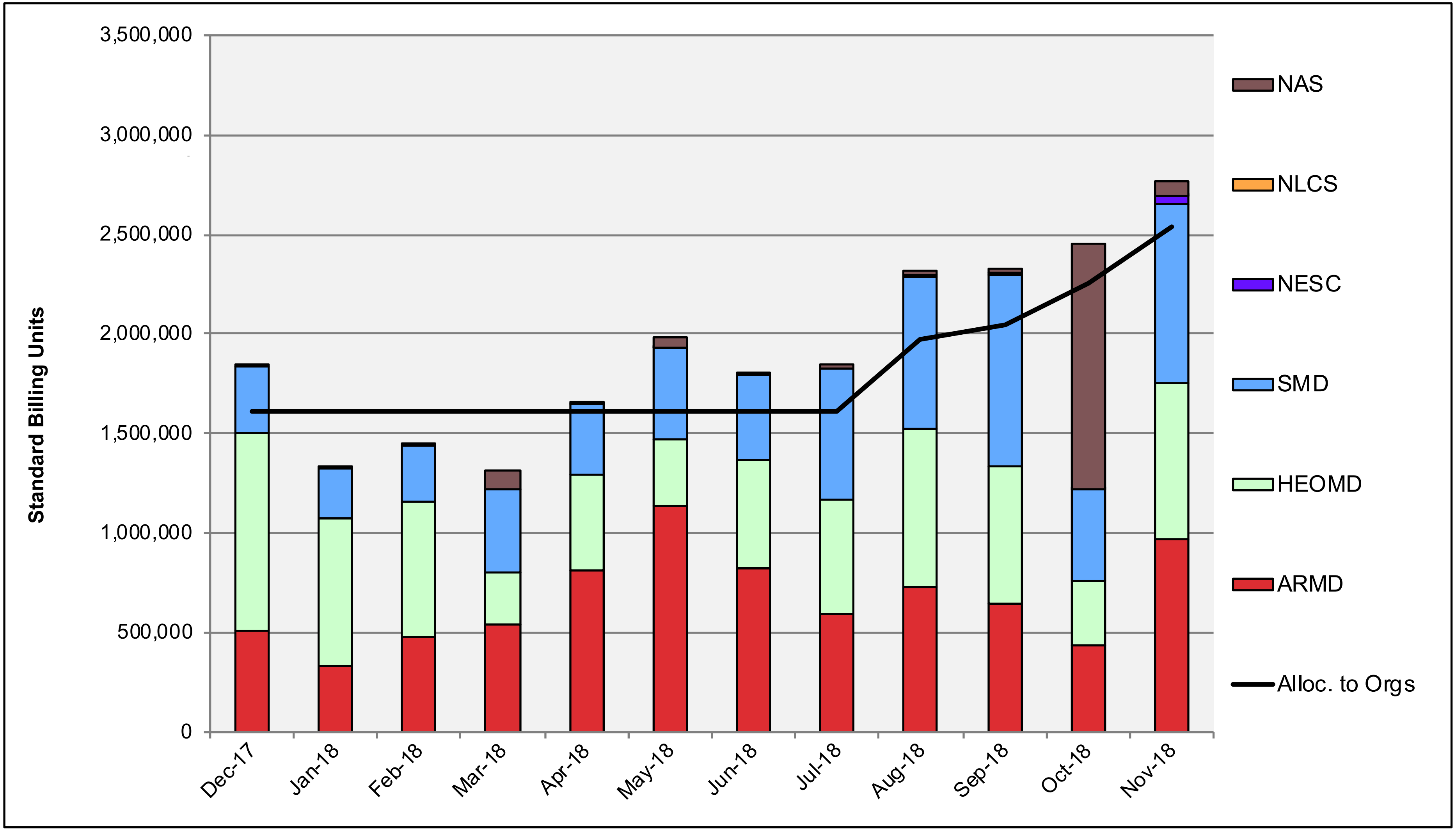
Pleiades:
Average Time to Clear All Jobs



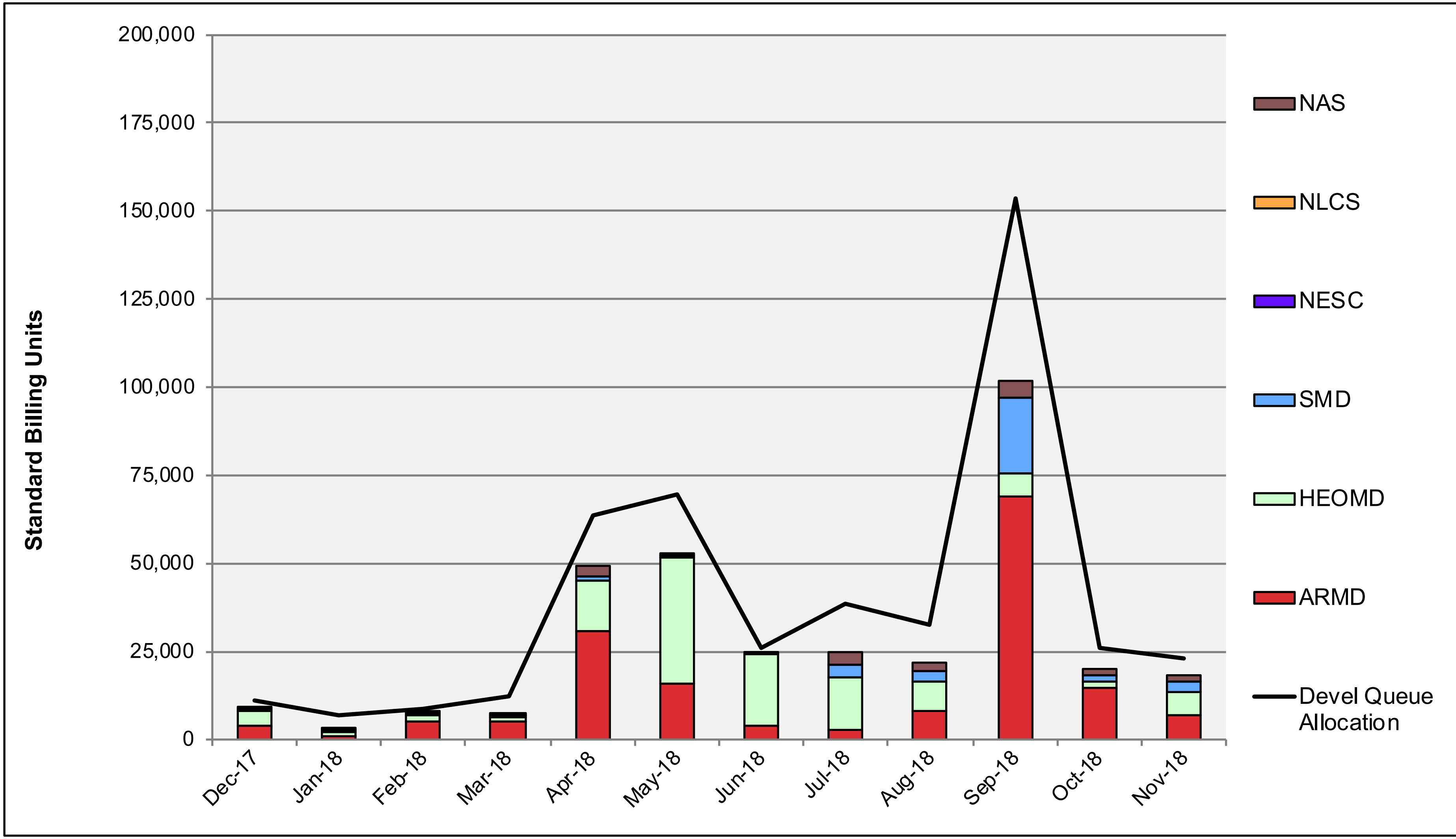
Pleiades: Average Expansion Factor



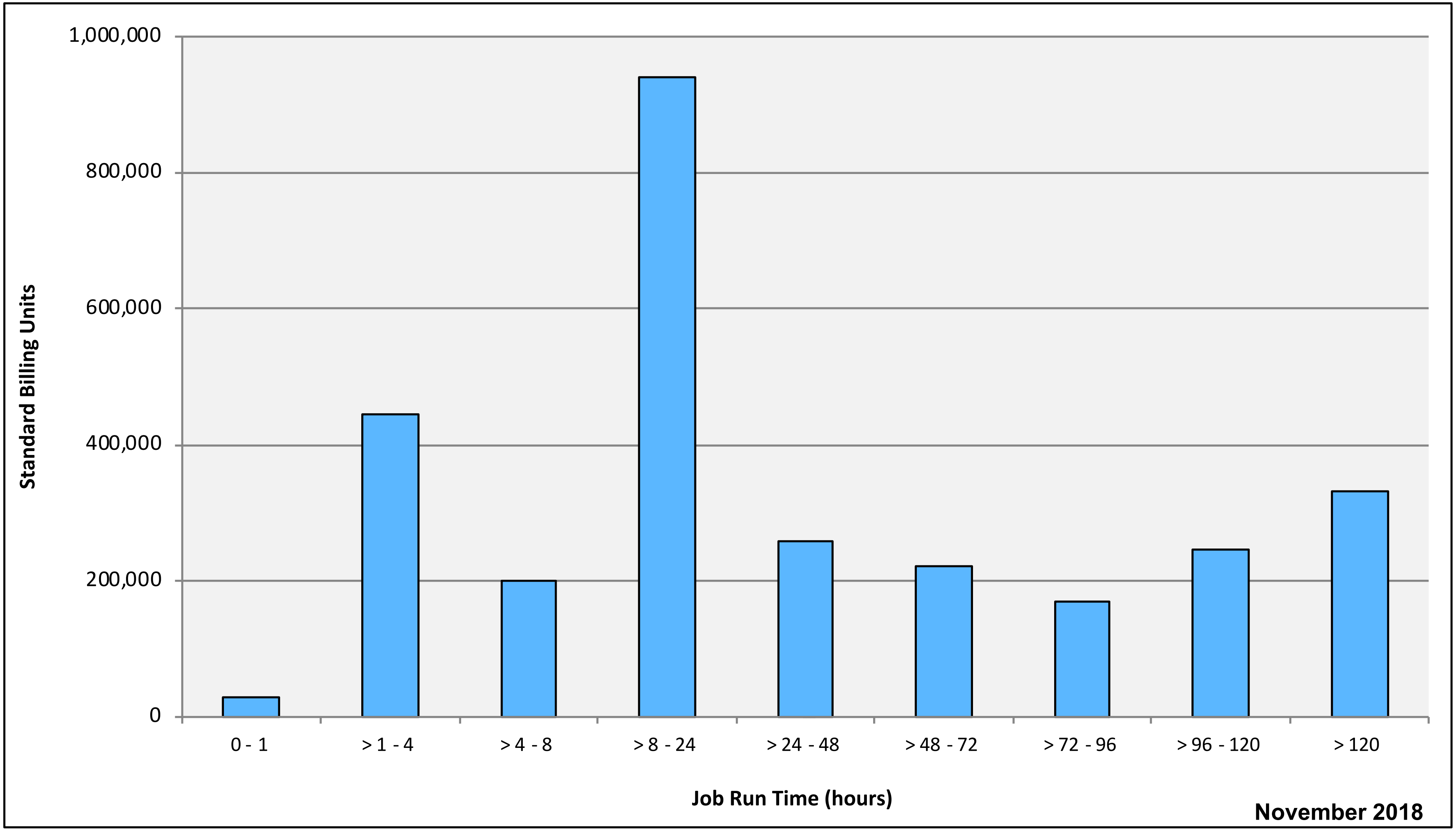
Electra: SBUs Reported, Normalized to 30-Day Month



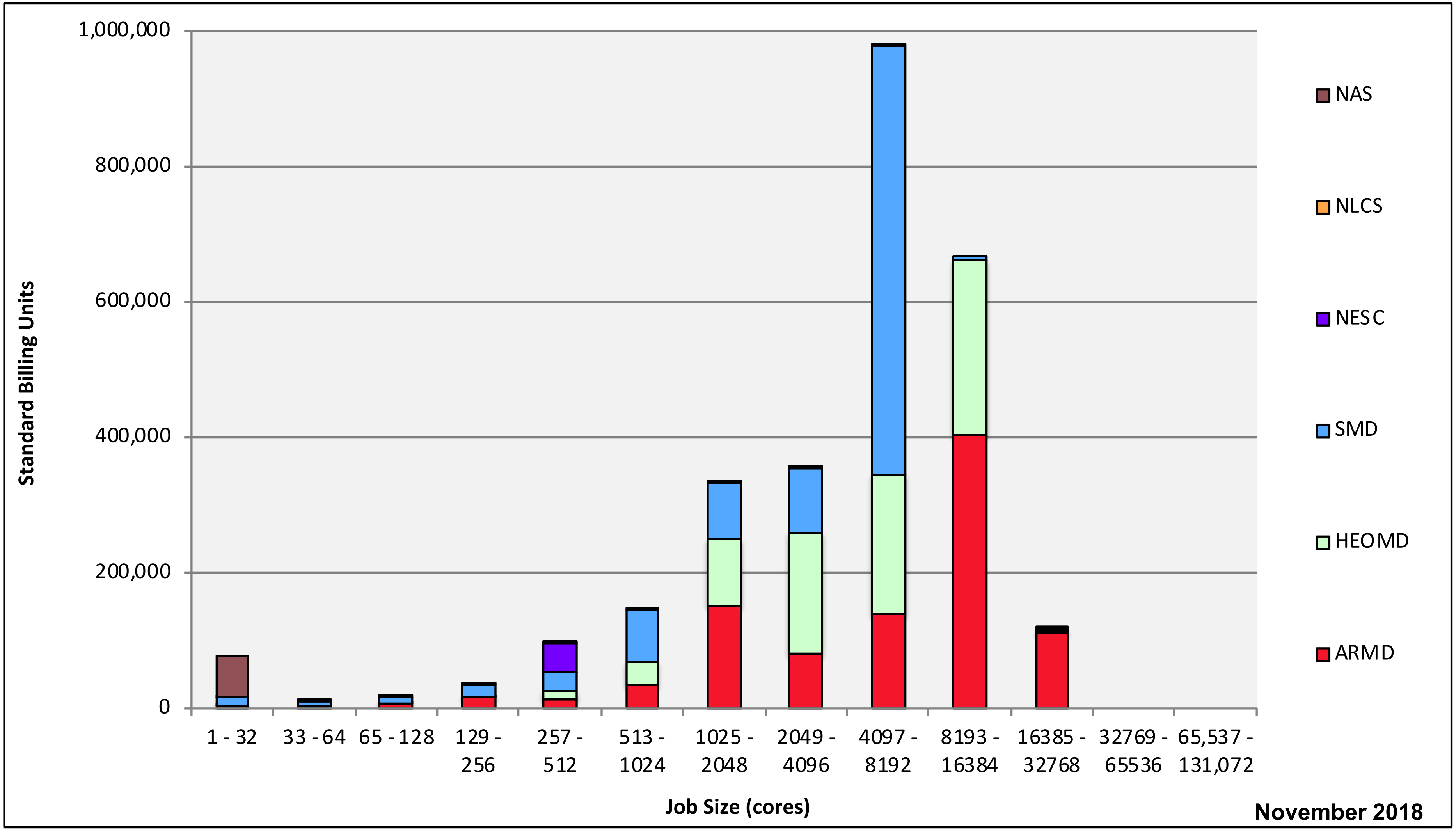
Electra:
Devel Queue Utilization



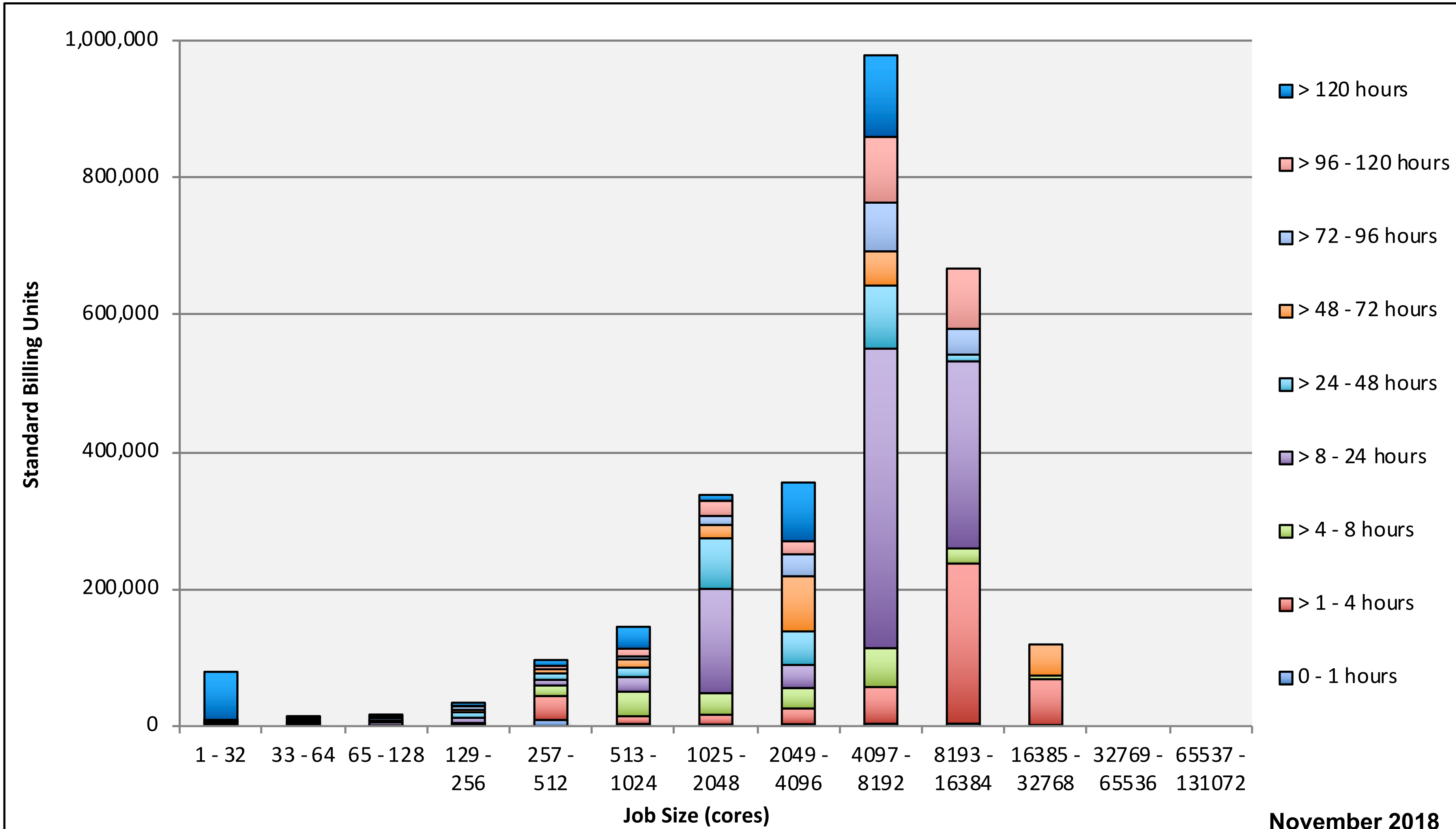
Electra:
Monthly Utilization by Job Length



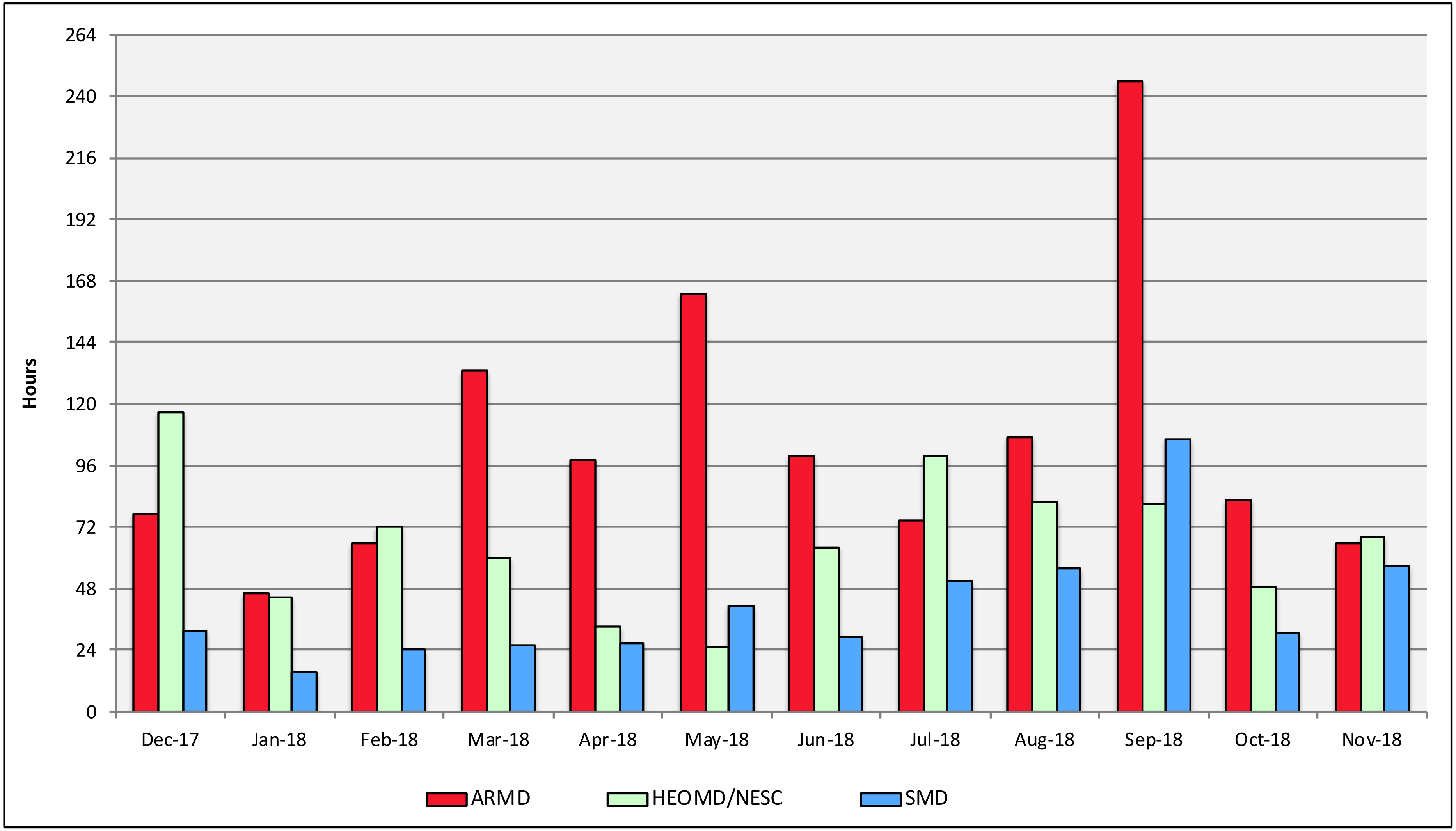
Electra:
Monthly Utilization by Size and Mission



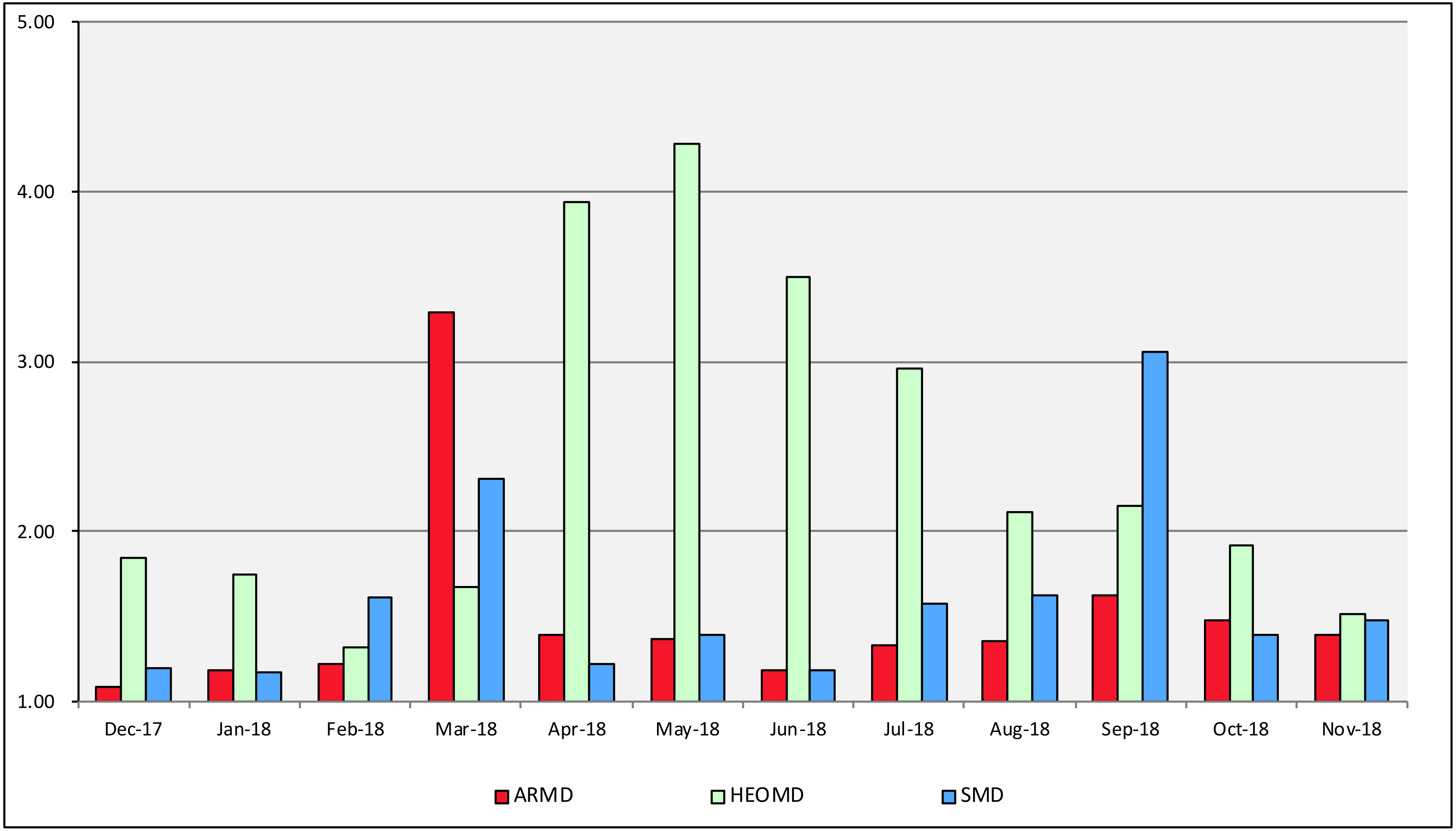
Electra:
Monthly Utilization by Size and Length



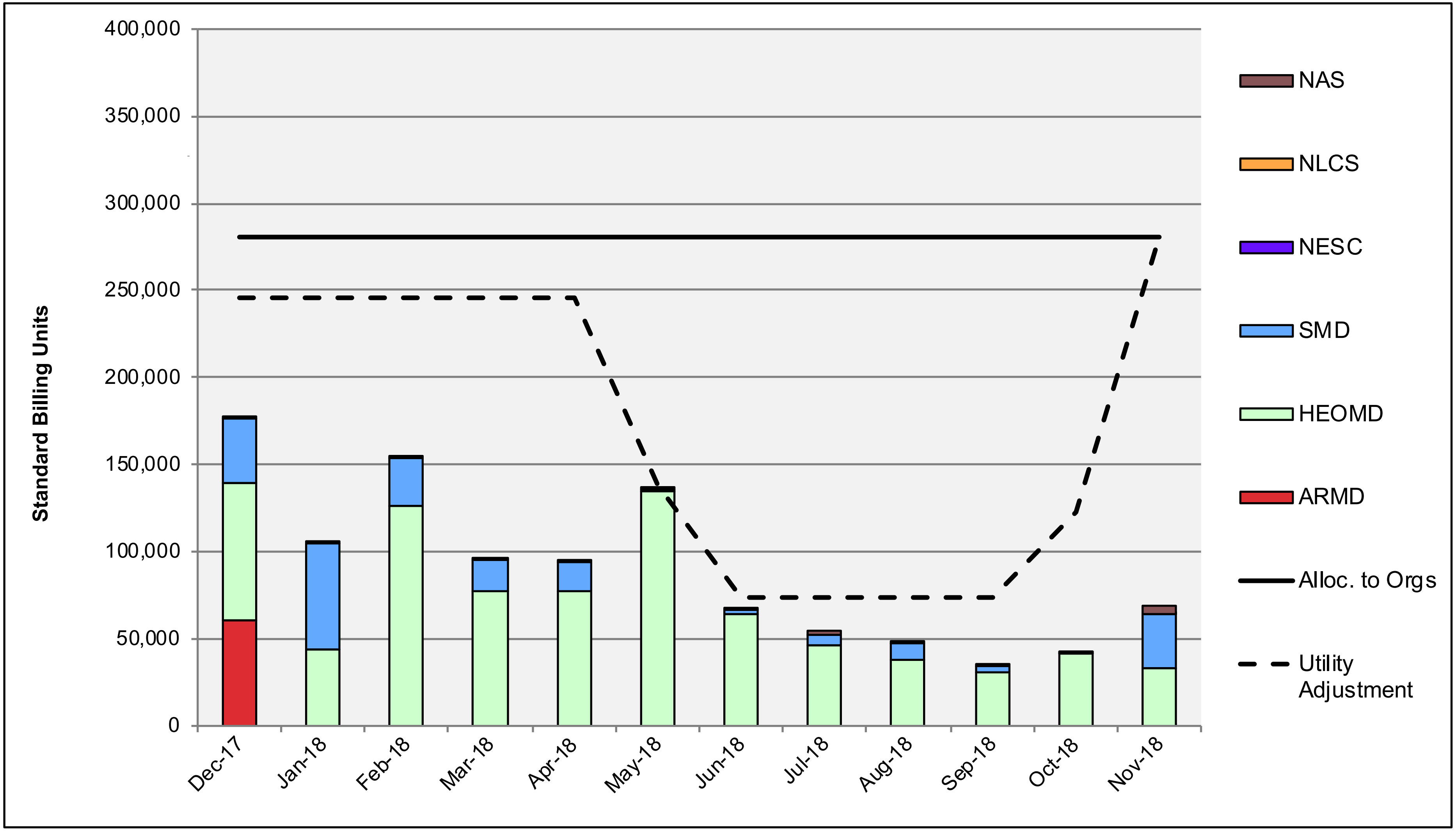
Electra:
Average Time to Clear All Jobs



Electra: Average Expansion Factor

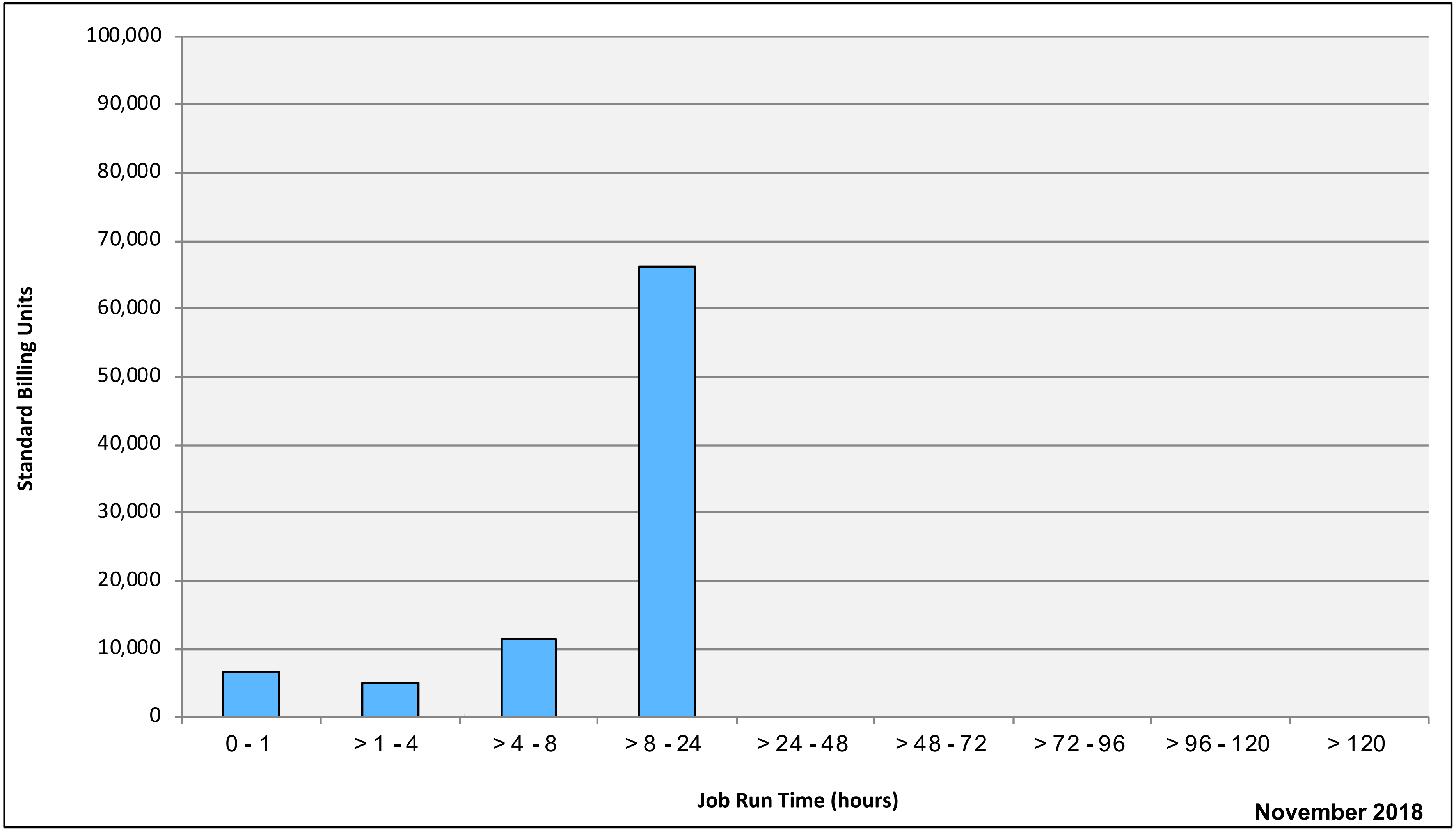


Merope:
SBUs Reported, Normalized to 30-Day Month

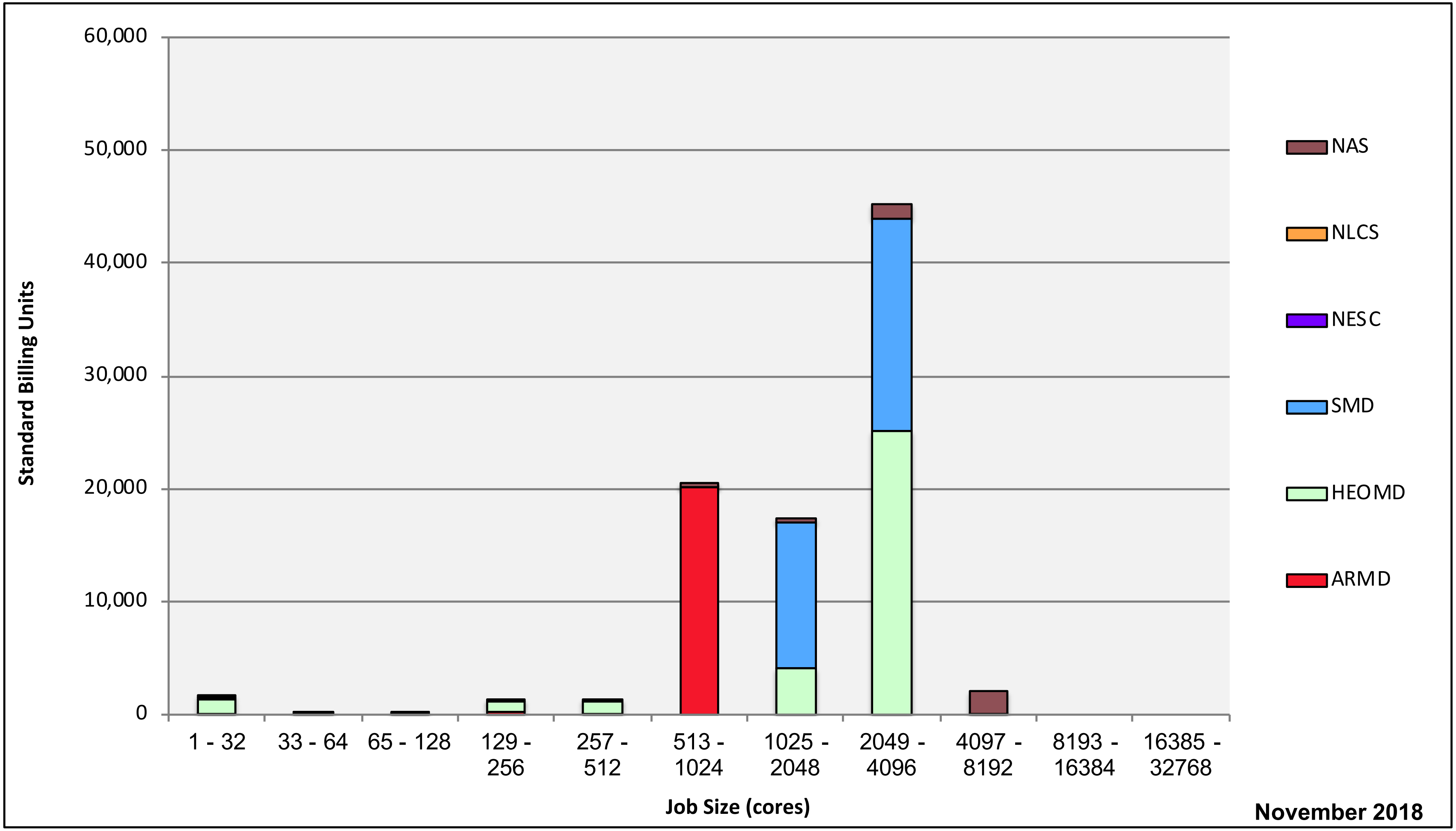


*Utility Adjustment: Multiple failures of chillers in N233A necessitated turning off a large portion of Merope

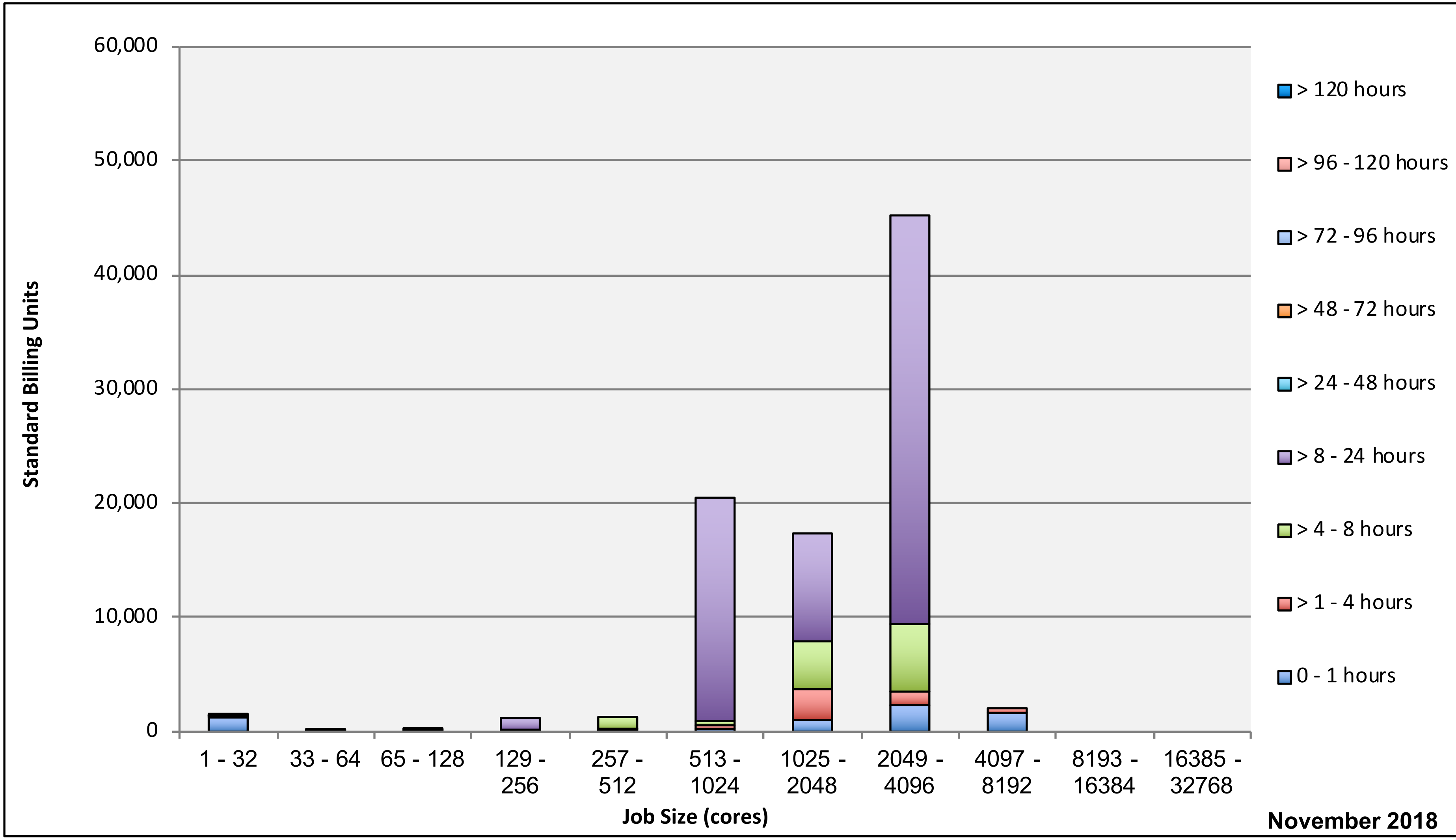
Merope:
Monthly Utilization by Job Length



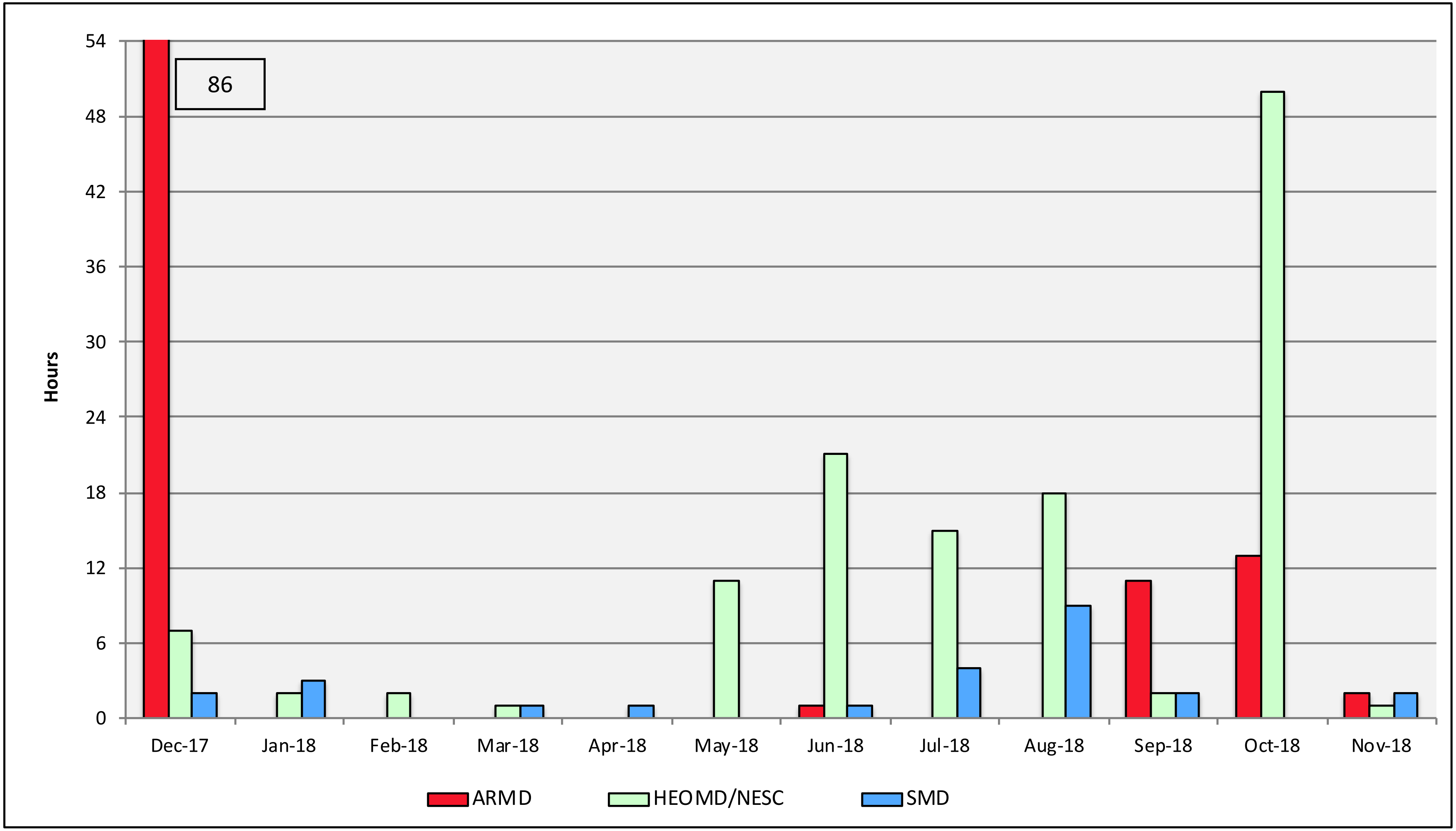
Merope:
Monthly Utilization by Size and Mission



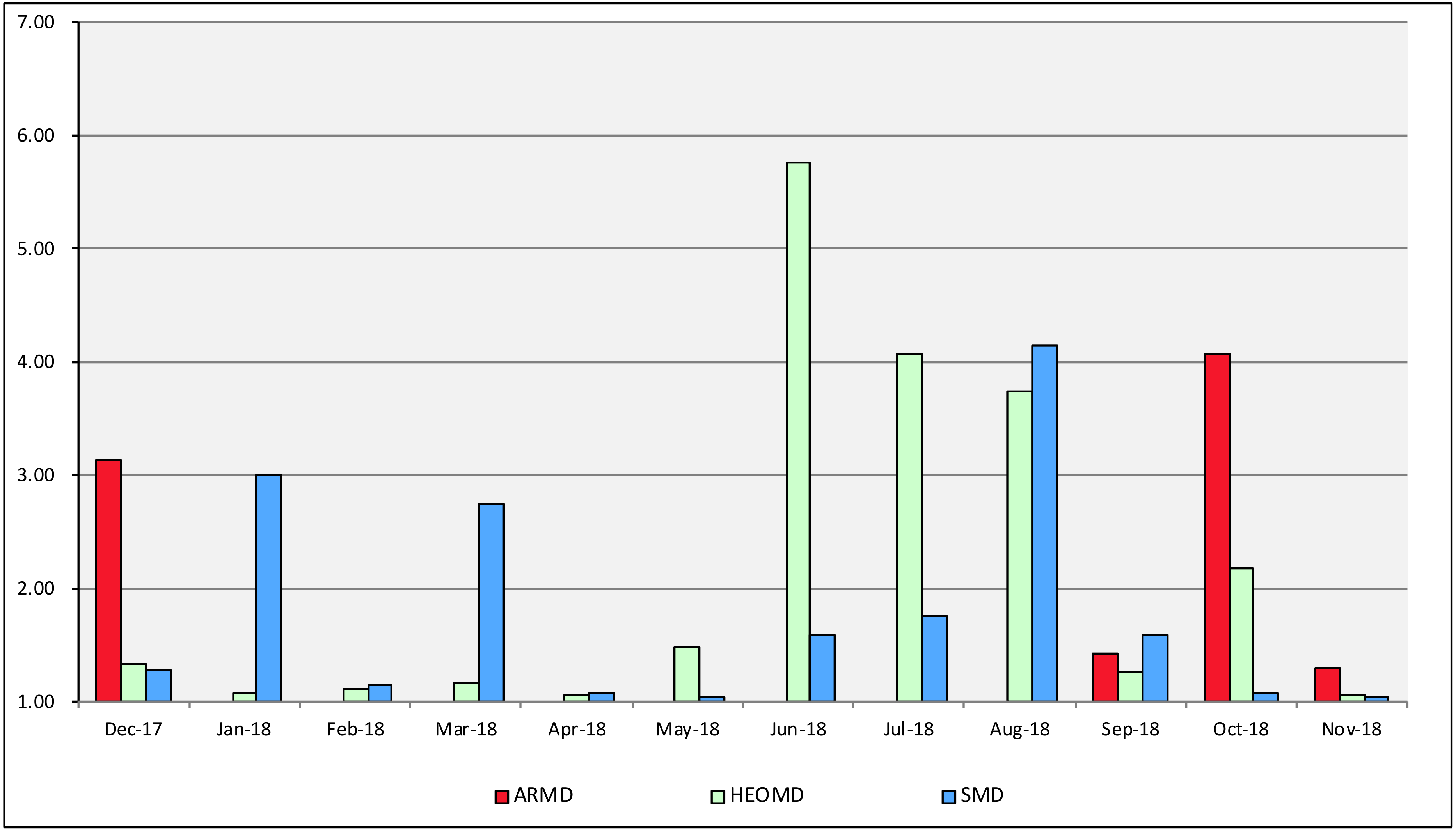
Merope: Monthly Utilization by Size and Length



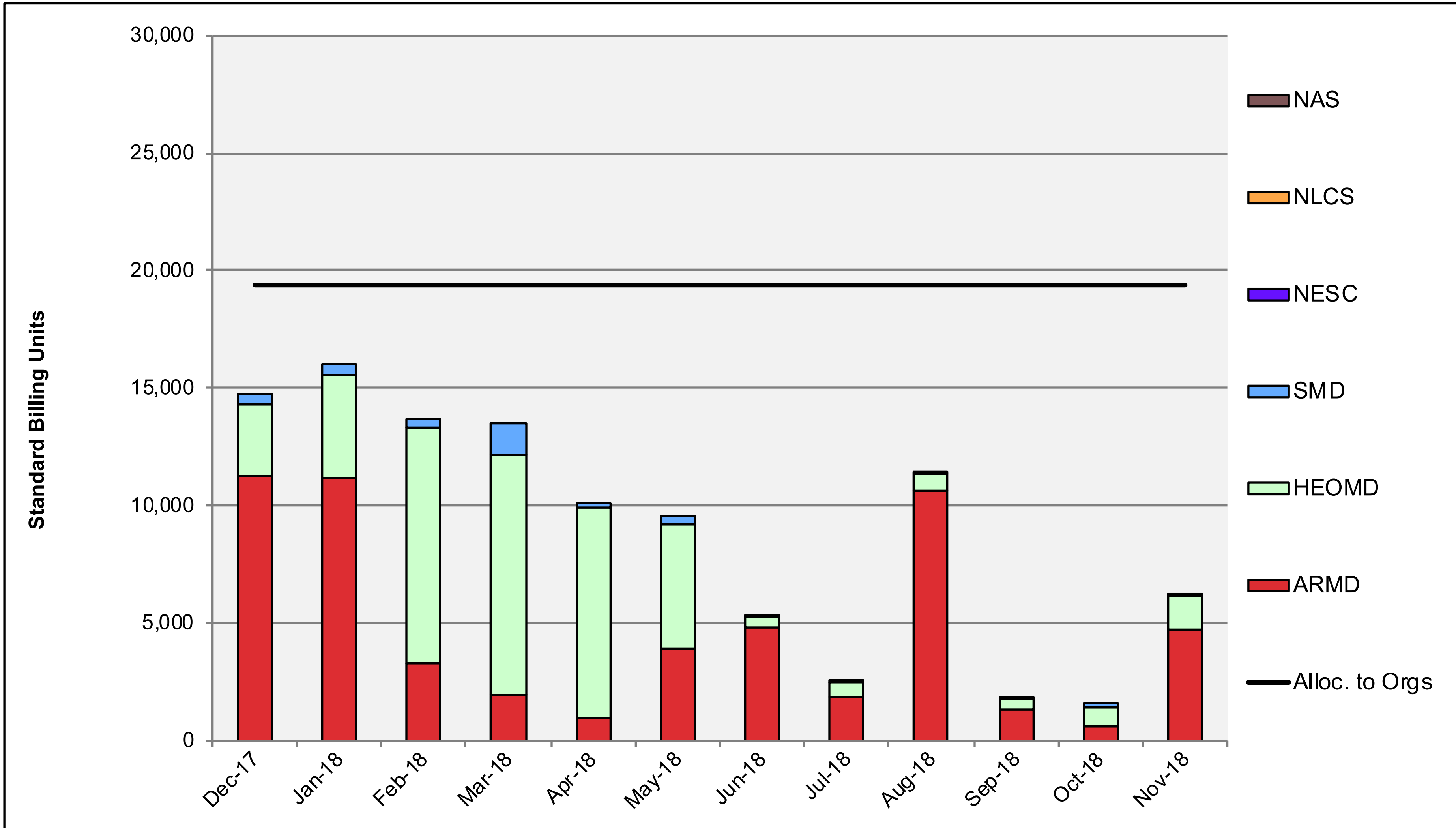
Merope:
Average Time to Clear All Jobs



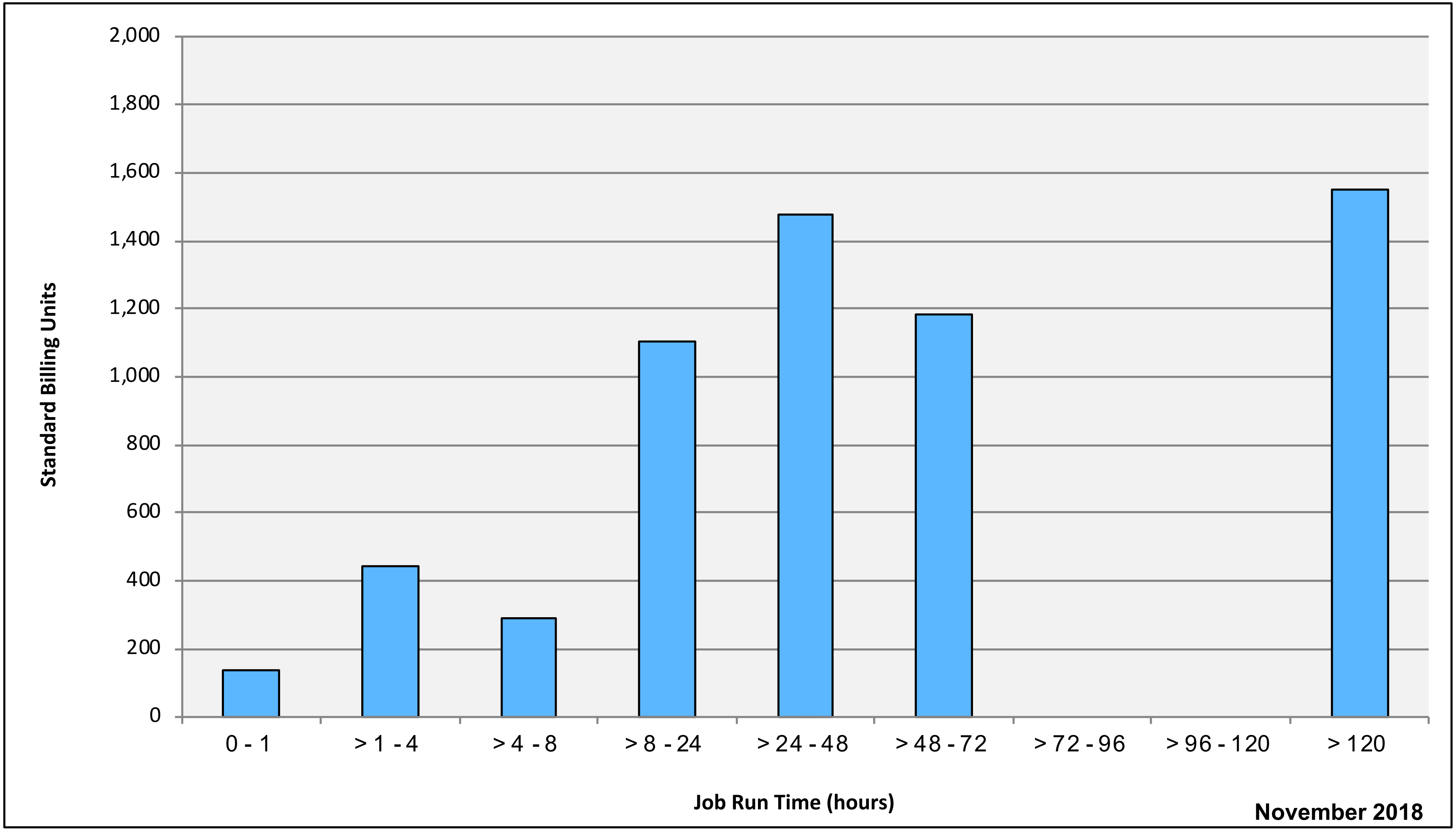
Merope:
Average Expansion Factor



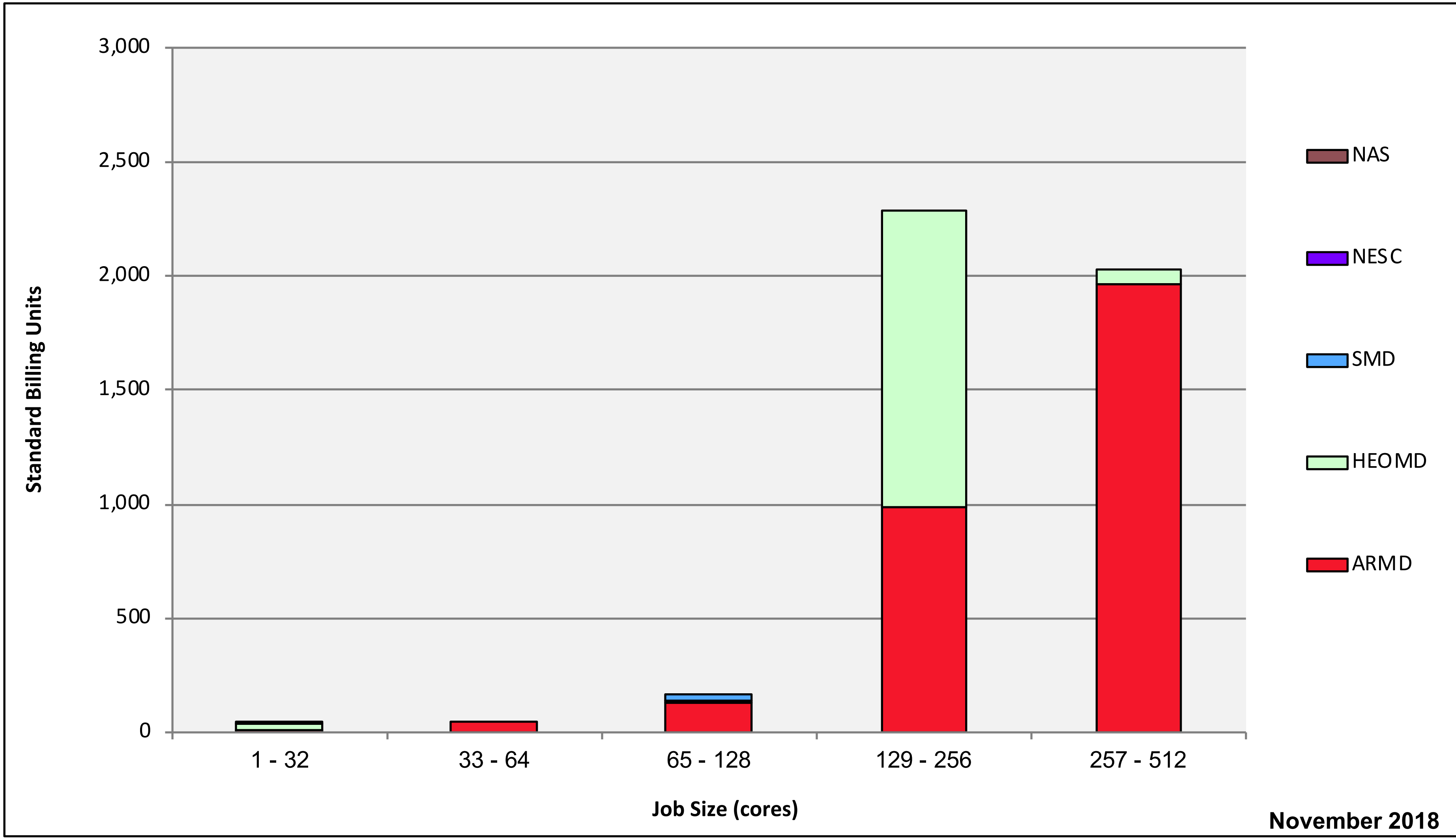
Endeavour: SBUs Reported, Normalized to 30-Day Month



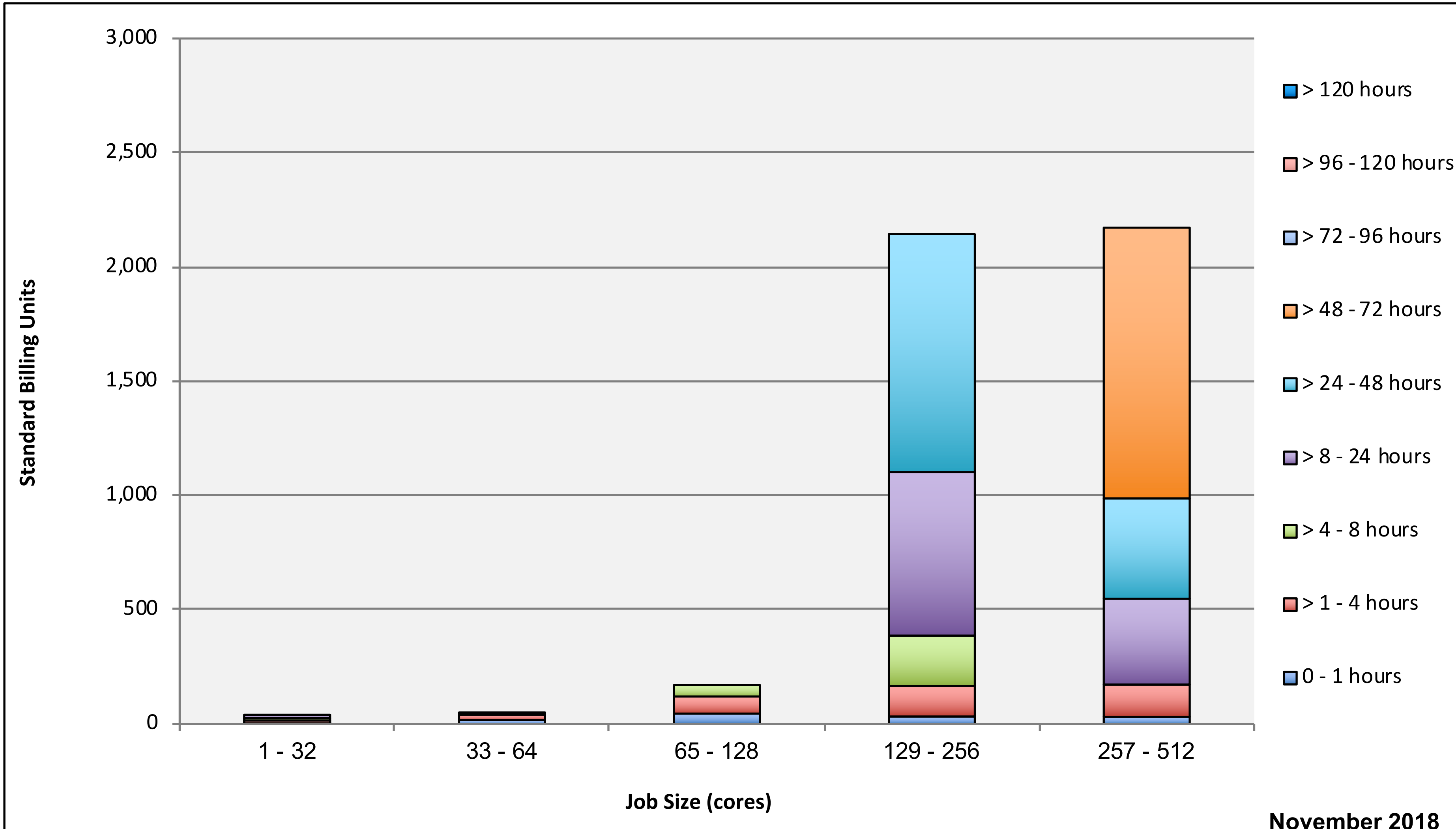
Endeavour: Monthly Utilization by Job Length



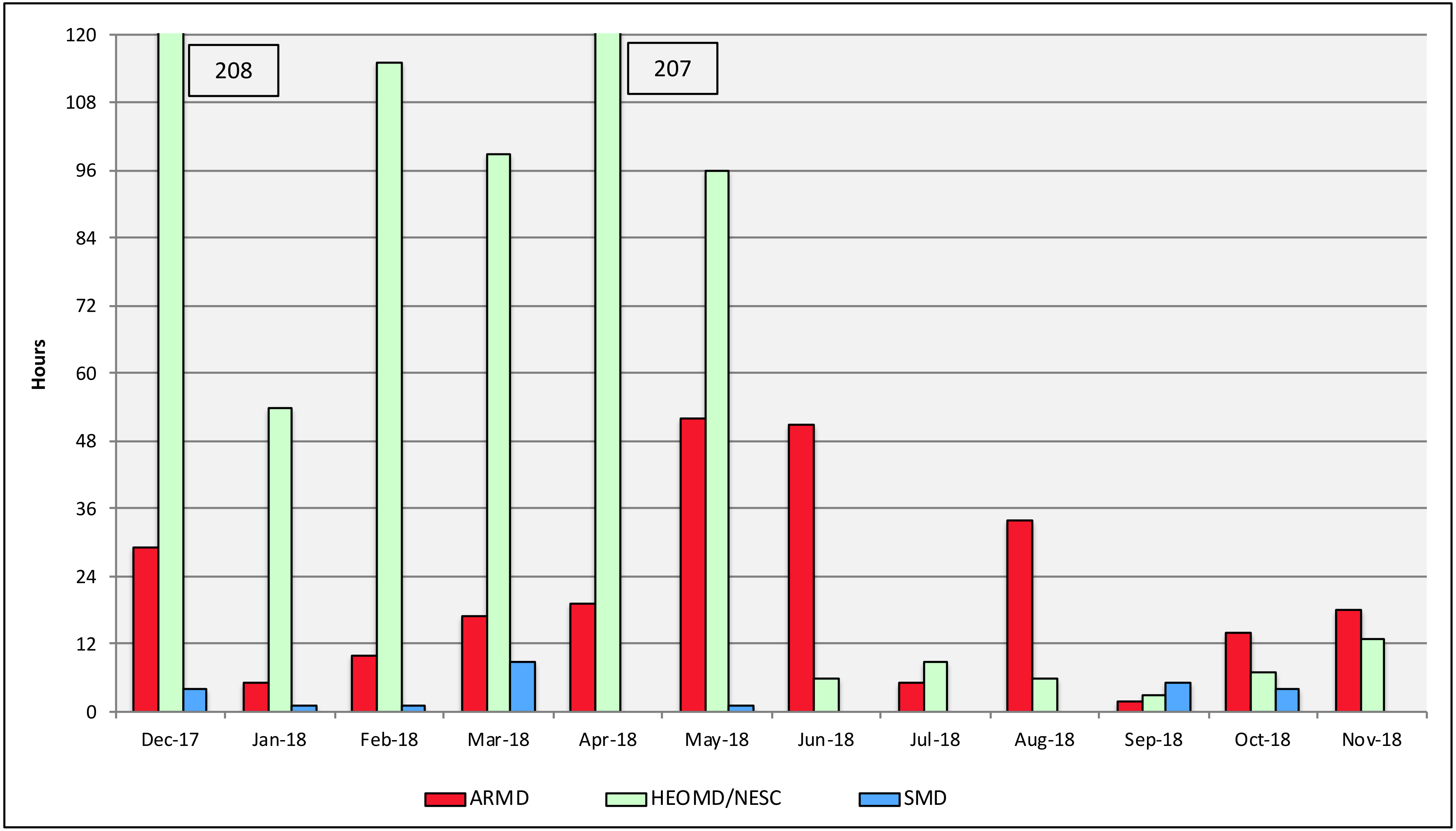
Endeavour:
Monthly Utilization by Size and Mission



Endeavour: Monthly Utilization by Size and Length



Endeavour:
Average Time to Clear All Jobs



Endeavour: Average Expansion Factor